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JAPANESE HOME LIFE.

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IT must be confessed that the ideas of Japan and the Japanese which we are likely to gain through the current literature of the day are apt to be sadly confusing. This, I am quite confident, is not from any desire on the part of writers on Japanese subjects to encourage any false impressions, but rather from the very fact that neither poet nor artist traveler—ay, nor many of the long residents in Japan, for that matter—have opportunity to see or take part in the home life of the people of Japan.

But few visitors to that country have been able, in so short a time, to become so thoroughly *en rapport* with the customs and life of this interesting people as Sir Edwin Arnold, whose graceful writings show us how he has thought with them, lived with them, and loved with them in a deeper and truer sense than many of the oldest foreign residents, although his stay was comparatively short. Yet even in Sir Edwin's writings on Japan we see the poetry rather than the prose of Japanese life; and this is not to be wondered at, for of all countries and people none could appeal so deeply to the poet as does this fairyland of flowers and romance. The very air one breathes, the delicious sense of rest and quiet, the graceful courtesy of the people, the romantic beauty of mountain or highway, city or dwelling—all these, and far more, complete an ideal picture that awakens enthusiasm in the prosiest of tourists or visitors. It could surely scarcely have been otherwise that the author of the Light of Asia, whose very heart-strings are tuned to the melody of poetry, should have struck the keynote of Japanese life and awakened naught but answering chords of most enchanting harmony.

So he has given us these in his writings on Japan so vividly and artistically that we can almost hear the soft-voiced welcome of the serving maiden, as the *soji* is noiselessly pushed aside, and amid the subtle fragrance of the plum blossoms sink back among the silken cushions with that delicious sense of repose, while lulled to rest by the melodic echo of the *koto* strings, and find ourselves once more in fairyland Japan. And would it were only true!

Yet we are not all of us poets, and few of us are artists, and so find that there is prose beneath the fragrant blossoms that the poet's pen has so lavishly scattered over things Japanese. On the

THE SIESTA.

other hand, we find that the sweeping assertions regarding Japanese ethics and morals—or rather lack of morals—as contained in other writings on Japan, are both unjust and untrue.

On the one hand, Sir Edwin Arnold tells us that the women of Japan approach our ideal of the angelic, while another writer cries out against the utter lack of morality in Japanese women. Such diametrically opposed statements are distressingly confusing, and the characteristics of "angelic immorality" are hard to conceive of, and must be rather paradoxical, to say the least.

Should we desire to gain any true idea of the "prose and poetry" of Japan, we must look into the details of the home life of the people; for, after all, it is the daily routine, the domestic and social duties, the thoughts, pastimes, and aspirations typical

to any people that mold the ethics and character of the nation itself. In a word, we must enter the homes of both high and low, there to learn facts and not "foreign impressions."

But, alas! the task is one most difficult to accomplish, for it must be acknowledged that the vast majority of foreign residents, and practically all transient visitors to the country, see little or nothing of the details of the home life of the people. And why? Is the life of the people just what they see it to be in its picturesque and courteous superficiality, and is it indeed all poetry, music, and flowers, and no earnest reality?

Indeed, there is; for the word "home" has the same tender meaning in the hearts of the Japanese as with us; and the cricket that chirps so lustily on the hearths of American or English homes would find a rival songster in the cheery little fellow whose contented chirp by the side of the glowing brazier, or *hibachi*, makes such sweet music in Japanese homes.

Apart from the diplomatic and consular representatives from Western countries, the foreign residents of Japan are chiefly composed of merchants, missionaries, and a comparatively small number of professional men. The merchant or trading class represent by all odds the majority of the foreign community. Numerically, missionaries would come next. Indeed, it would not be an unfair estimate to state that these two classes constitute at least four fifths of the foreign population. Trading, as far as foreigners are concerned, is still limited to the treaty ports, including Yokohama, Kobé, Nagasaki, and a few others. Socially, the Japanese merchant ranks below the humblest tradesman, and, as all foreign trading with the interior must be carried on through the medium of these Japanese commission merchants, it is with this class of people that the majority of the foreign residents come in contact, and then only in their business relations, and seldom socially or intimately; although, were this the case, the idea gained of Japanese home life would be misleading, for the Japanese trader very soon learns to conform himself to the manners of his customers, and can not be regarded—as thus met—as typical of the truly Japanese.

The missionaries as well, for the most part at least, have little opportunity to study the details of the social or home life of the people they are working among. Theirs is a duty and vocation which from its very nature would render this well-nigh impossible. They are teachers, not students; they are bearers of spiritual truths, and must needs open warfare against the existing creeds of the people; and this attitude in itself would, in the majority of instances at least, debar them from entering into the pursuits or pastimes of the people. Before leaving the subject of missionaries, I would call attention to the frequent allusions made by the

SILK MERCHANT. Many of these shops open directly on the street. To the right is the cashier, fenced in by his latticed "office."

representatives of certain missions, to the disrespect and disregard paid to them or their teachings by the Japanese. Such assertions are too sweeping, to say the least, as well as misleading, for many of the foreign missionaries in Japan have gained the high esteem of natives, and have endeared themselves, both by their noble, self-sacrificing lives, as well as ever ready sympathy and friendliness. There have been many missionaries sent to Japan during the past decade who are educationally sadly incompetent to meet the emergencies that present themselves in Japan. It must be borne in mind that the standard of education of the present generation in Japan is most high. The works of Huxley, Spencer, Darwin, and many others have, for the most part, been translated into Japanese, and the students and graduates of the university, the *Dai gakko*, are able to compete educationally with men from our best colleges and universities. The eagerness for knowledge that one finds so universally displayed among the Japanese, together with the remarkable advance in this direction that the nation has made during the past twenty years, and the prominent position Japan is assuming in its relations to America and European countries—all this commands our unbiased interest and respect.

The task of endeavoring to portray a clear, although of necessity incomplete, view of Japanese home life is one of no little difficulty. It would seem almost as difficult as an adequate description of a Beethoven sonata would be without the aid of music. For there is a subtle "something" about Japan in which, perhaps, the exquisite harmony of the land—the scenery and the people—plays an important part; yet a "something" that is wont to cast a charmed spell around one, and causes a former resident, like myself, to look back to the years spent in the "Land of the Rising Sun" as to the memory of some peaceful vision of fairyland. This indefinable charm can not be described in mere word-pictures, and yet escapes few visitors to Japan, and is seldom lost even after long residence in that country.

The sense of restfulness that pervades our Japanese towns, in bold contradistinction to that feeling of noisy hurry and feverish excitement of a busy American city, has been attributed to the comparative absence of horse traffic in the former. Undoubtedly this is a potent factor, but not the only one which gives that sense of quiet and repose already referred to. The courteous politeness of the people, both rich and poor, the general evidences of lightheartedness among even the poorest laboring classes, the absence of that distracting hurry and rush so typical of our great business centers, and in addition to all this the picturesque houses and streets, the spotlessly clean homes, the evidences everywhere of a national love for the beautiful and artistic, the absence of saloons

or barrooms, and their substitution by public bath-houses, at almost every corner—all these must be regarded as factors productive of this sense of quiet and rest. Then, again, the strange commingling of the new and the old—for, turning aside from some busy street thronged with shoppers, venders and tradesmen, a few steps may find us approaching some majestic temple gateway, leading to the shrine or tomb of some great hero of centuries gone by. Ascending the time-worn stone steps, and standing beneath the shadow of the lofty gabled roof of the gateway, our gaze may follow the intricate maze of lacquer and bronze architectural adornment until it is lost in the shadowy gloom overhead. On either side of the two central columns, and shut off by a railing, are the colossal figures of the "guardians of the temple," grim and gaunt, with sword in hand. Flanked on either side are the tall bronze or stone lanterns of the temple, and still beyond, back even of the font of water and the great temple bell in its gabled belfry, is the shrine itself, a fitting resting place or tribute to one who has served his country well, guarded as it is by gnarled and ancient pines and lofty cryptomarias that were ancient when the grandsires of the happy throng below ascended these self-same steps to offer a tribute to the memory of the hero.

There is a marked similarity in the daily routine of the inmates of Japanese homes, whether they be homes of the rich or poor, the official or tradesman. The wife is always the mistress of the home, and hers is the duty of in every way possible rendering the life of her husband happy—and to be happy herself, as far as he knows. The instruction of the daughters of the home in the various domestic duties also devolves upon the mother. The wardrobe of the entire family is the work of her hands, with the assistance, perhaps, of an aunt (*obāsan*), maid, or her growing daughters. The latter, by the way, are taught how to sew while yet quite little tots, and as they grow older in years and skill, are initiated into the mysteries of art needlework. Then the daughters are instructed in music, a certain knowledge of the *samisen*, *koto*, or some other musical instrument being regarded as a requisite accomplishment in even the poorer and middle classes, while the daughters of the higher classes and nobility are well versed in art, music, and the poetry of the country. The other accomplishments deemed desirable in women consist principally in the artistic arrangement of flowers and the details of ceremonial tea making and drinking (*cha-no-yu*).

The recitation, or reading of historical poems (*utai*) is a favorite study, especially if some romance is interwoven into the story. Usually the dramatic poems (*iōrori*) are ceremoniously read or sung by the young maidens, while an elder sister or teacher will thrum a minor accentuated accompaniment on the *samisen*. Some-

GATEWAY OF AN ANCIENT BUDDHIST SHRINE.

times the story of the *utai* is told in prose to the eager group of children gathered around the glowing brazier, or *hibachi*. The latter, it must be confessed, in spite of its cheery appearance, radiates but a scant amount of heat in comparison with the open grates of the Occident. Such a family group may be seen in thousands of homes in Tōkyō alone, on a winter's afternoon; the boys, if back from school, resting contentedly on the white *tatami*, or studying the morrow's lessons in some quiet nook; the little maidens, demurely grouped about the *hibachi*, busily plying their needles, while listening to some story told by the old aunt or nurse, that may be acting as instructress. The contented hum of

SINGING GIRLS PLAYING ON THE KOTO AND SAMISEN.

the quaint old iron kettle, resting over the glowing coals, supported by an iron tripod thrust into the ashes of the *hibachi*, suggests its entire readiness to assist in the preparation of tiny cups of fragrant tea for any chance guest that arrives, or for any member of the family that wants a steaming cup of this delicate beverage—which is so much more dainty and delicious as prepared and drunk by the Japanese than by us.

It is then that the telling of stories finds its place in Japanese. The deeds of heroes, the romances of ancient dynasties, mystical lore, stories of ghosts and ghouls, and of the wicked and revengeful deeds of fox or badger sprites—this folk lore, historical or mythical, as it may be, has become so blended with the home life

of the people that one can not well dissociate the one from the other. The story of *Kogo-no-Tsuboné*—properly an *utai*, or historical poem—is a favorite on account of the sweet romance it contains.

THE STORY OF KOGO-NO-TSUBONÉ.

Long, long years ago, before the *Shoguns*, that now sleep in their ancient graves in Shiba, had gained power, and before the advent of foreigners had been even dreamed of, the peace-loving young Emperor Takakura, a monarch of the imperial line, graced the sacred throne of his ancestors.

But the imperial power of Takakura was but a nominal one, for the prime minister—one Kiyomori, of Taira descent—virtually ruled the land, and, to accomplish his ends more adroitly, had even caused his daughter to be made empress. Thus the peace-loving young monarch was a mere tool in the artful hands of Kiyomori. Indeed, his power was great, for the emperor could not have declared war or made peace against Kiyomori's tyrant will.

So, while the prime minister was scheming with his daughter the empress, the young monarch was forced to seek consolation in music and art, and found a willing and loving follower in one of his retainers, Nakakuni, who himself was a most skilled performer on the flute. Now, it happened that among the royal musicians at the palace there was a lady in waiting to the royal household who in music far outranked any other. Fair as a dream, gifted with the sweetest of voices, Kogo—for this was her name—was able to awaken music from her *koto* strings that seemed to spring from the very soul of the instrument. None but the tapering fingers of the fair Kogo could create such entrancing harmony, and it truly seemed as though the silken strings would murmur a loving response to her gentle caress.

Frequently the flutist Nakakuni would accompany Kogo's music and song, while the young emperor would listen like one entranced. These three passed many happy hours together; but as time wore on, the young monarch realized that sweet Kogo's music and verse had awakened love. But, alas! Kiyomori learned of the emperor's infatuation, and poor Kogo was compelled to secretly flee to the mountain forests of Saga in order to escape from the relentless persecutions of Kiyomori and his daughter the empress.

On learning of Kogo's flight from the palace, Takakura at once ordered his faithful retainer Nakakuni to go in search of the missing maiden, and look far and wide, and not to return until he had found her hiding place. The fleetest horse of the royal mews was made ready, and Nakakuni, bearing with him a message from the Emperor, was soon speeding toward the gloomy mountain of Saga.

Long he rode; the giant cryptomarias that flanked the highway towered overhead, and well-nigh shut out the remnant of the dying day. Night dropped her black pall over the earth as he entered the dark forests of the mountain, but far, far above the tree-tops the silver moon shone forth, with the stars peeping out

A Geisha, or Professional Entertainer and Musician.

one by one, as though desiring to aid the loyal retainer in his search. Again and again he would check his horse and stop to listen, for it seemed that he could hear the melodious tones of a *koto*. At last, when, far late into the night, he arrived at the ancient temple of Horin, the sounds became more audible, al-

though still distant. Was it the distant moan of some far-away tempest among the mountain peaks? Was it merely the night wind sighing through the lofty pines overhead? Or could it be the plaintive, liquid melody from the harp of the lost one? Checking his panting, foaming steed, Nakakuni listened intently, and while listening his heart began to beat wildly, for he now recognized the music of an old love song, and the magic touch of Kogo's fingers on the *koto* strings. Led by the guiding music, he soon reached a miserable-looking hut, whence the sounds proceeded. Dismounting at the door of the hut, he proclaimed himself a royal messenger and demanded admittance.

A voice from within answered that no dweller in so humble a hut was worthy of being the recipient of a message from the emperor, and that surely he had made some mistake. Not to be put off, however, Nakakuni declared that he had recognized Kogo's music, and that it was for Kogo that he was seeking. Then, indeed, he was made welcome to the humble abode; but, after delivering the emperor's message, the fair Kogo announced her determination to forsake the world forever and live the holy life of a recluse, and begged that Nakakuni would secure the emperor's pardon for her enforced disobedience to his commands. In vain did the faithful messenger endeavor to alter this determination, and presently the two fell to talking of the happy past at the palace. The *koto* was brought forth, and Kogo once more sang those well-known love songs, and the harp strings rang again with melody. The moments rolled into hours, and the day was breaking when Nakakuni took leave of the weeping and disconsolate maiden and rode slowly back to the palace alone.

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Sometimes the story is ended here with the conclusion that Kogo became a Buddhist nun and spent her life in ministering to others, self-abnegation, and prayer; but the history of the romance, as set forth in the *utai*, is kindlier, for the emperor again sent for the sweet musician, who was finally prevailed upon to return to the palace, where she was restored to her former honorable position in the imperial household.

In rendering the above in English I have endeavored to retain, as far as possible, the quaintness of the original with which almost every Japanese is familiar. Regarding the purely legendary lore of Japan, this is as a rule most weird and mystical. The large variety of supernatural beings, for the most part of a purely psychical origin, is truly startling; indeed, it would be difficult to imagine or invent any grewsome form for an apparition that is not already an old inhabitant of Japanese "ghostdom."

But for "fireside" stories it is, after all, the recital of the uncanny and magical deeds of foxes and badgers that awakens the

In the Daidoku, or Kitchen, during the Preparation of the Morning Meal.

greatest interest among the children, and which are, for the most part, believed in even by the elders. In fact, among the more illiterate classes to be possessed with the spirit of a fox (*kitsuné-tsuki*) is a form of zoanthropy not infrequently met with, although the disorder is more likely to be assumed than real, and the epithet *kitsuné-tsuki*, or "fox-hearted," is more apt to be figuratively applied than otherwise. Undoubtedly the popular belief in the magical powers of foxes and badgers in Japan is as extensive as the frequently unexpressed belief in the supernatural found in this country. The educated classes will decry any such superstitious belief, and yet will tell you of alleged experiences of their friends or relatives with foxes or badgers, which are "very strange and not to be accounted for." Fox and badger stories are therefore highly appreciated by the juvenile members of any Japanese family, principally on account of their "authenticity," and because of that fascinating condition of fear and "the creeps" that their recital occasions. Here is a good badger story, the truth of which I can vouch for, insomuch as there is a field of Inami near Kyōtō, and that it is a grewsome spot well suited for a trysting place for ghouls and ghosts.

THE BURIAL AT MIDNIGHT.*

Not far from Kyōtō, in the smiling hill-land of Harima, there is a broad, open plain known as the "Field of Inami." Although surrounded by verdant hillsides, this plain is bleak and barren; great gusts of wind sweep over the long, dry grasses, and no farmer or peasant has ever found a home in this desolate spot. Yet the great highway to Kyōtō runs just to one side of the plain, and on this road a postman used to carry his load of letters once or twice every week. A little bypath leads across one corner of the plain, lessening the distance to the city, and this path was a great favorite with the postman, as it made his journey so much the shorter.

Going one day as usual to Kyōtō, he reached the field a little later than was his wont, and night came on before he had advanced very far. Without a light or the means of procuring one, he wandered aimlessly on for a while, but finally seeing that he had missed the path in the darkness, resolved to pass the night where he was, with the sky for a coverlet. Without giving a second thought to all the ugly stories told of the field, the ghosts and malicious fox-sprites said to hold their nightly revels in that spot, the postman bravely determined to make the best of it, and

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* This tale was first translated from the Japanese into German, and read, among others, before the Gesellschaft für Völkerkunde in Ost-Asien, in Yokohama, by F. Warrington Eastlake, Ph. D.

was just looking for some sort of shelter when he caught sight of a little, half-ruined hut. Drawing nearer, he found that it was a sort of watch-house, such as the peasants build near the rice-fields in order to protect the growing grain. Overjoyed at having found even this poor shelter, the postman entered the little hut, and, throwing himself on a heap of dried grass, was soon fast asleep. Perfect silence reigned over the sterile plain; only now and again the far-off hoot of an owl or the mournful cry of some night bird broke the stillness of the night.

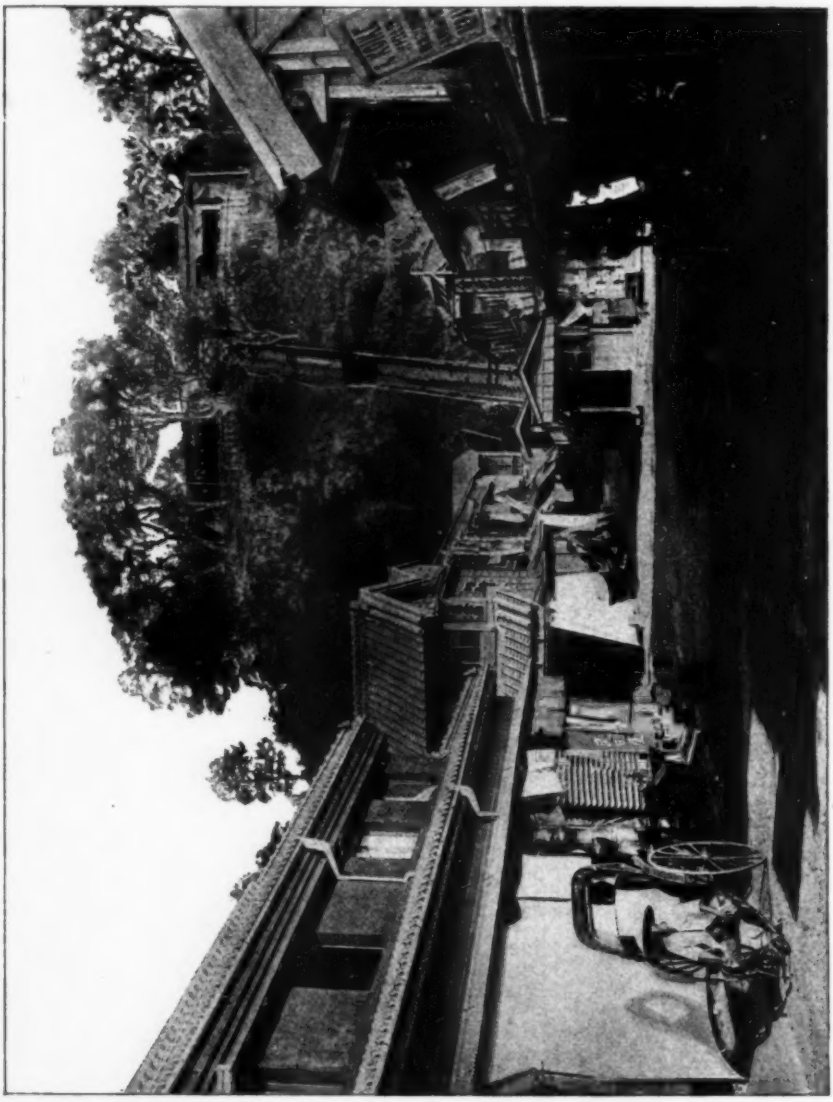
Several hours had passed, when the sleeper was suddenly awakened by the deep, sonorous note of a bell. The sound seemed to come from the western portion of the field, and all at once the startled sleeper heard a tramping as of many feet, and a confused murmur of Buddhist chants and prayers. Nearer and nearer came the crowd of people, to the listener's great astonishment. "There are no houses in the field," thought he, "and anyhow no one would think of going at midnight to such a deserted and ill-omened spot." The stars were shining brightly, but no moon illumined the scene, so that the trembling postman could only see objects very near him. Nevertheless he peeped cautiously out of his hiding place and saw, to his unbounded surprise, a long procession of men bearing torches and lanterns. In front of all marched a tall priest, reciting the Buddhist invocation, *Namu Amida Butsu*, in a clear, loud voice. "It is a funeral procession!" thought the frightened listener, and crept farther back into the shadows of the hut.

As soon as the mournful procession had reached the little hut a halt was made, and the coffin-bearers stepped forward. Scarcely five paces from the hut the grave was dug, and the coffin placed in it. The priest then threw the earth back into the grave and built a little mound above it, and finally placed a few sticks covered with Buddhist characters in one end of the mound. Without further word the somber procession turned back, and moved slowly away in the same solemn and impressive manner, leaving the postman in a most pitiable frame of mind. It was quite bad enough to be compelled to spend the night in such an uncanny and grewsome spot; but the late hour, mysterious burial, and the proximity of the freshly dug grave were enough to frighten the bravest heart.

As if chained to the spot by some evil spell, the postman kept staring at the little mound before him. Suddenly, while he was gazing fixedly at the grave, it began to rock slowly from side to side. Quicker and quicker became the rocking, while the involuntary spectator underwent an agony of terror. Faster and faster still rocked the mound, until it fell over with a great shock, and a naked, horrid thing jumped from the grave and ran toward the

MEAL TIME. Each member of the family has a lacquered table to himself, while the maid waits in readiness to replenish the bowls with rice served from the covered bucket.

postman. In an instant he remembered that horrible ghouls always attend a burial, and that these ghouls often kill and eat living beings. There was no time to lose, for the creature had already reached the entrance of the hut. Crazed with fear, the



THE "ONE HUNDRED STEPS" LEADING TO THE BLUFF AND TEA HOUSE, YOKOHAMA.

postman drew his sword and made one desperate cut at his enemy, and then, without daring to give a second blow, ran out of the hut and into the night.

Hours seemed to have passed before the postman arrived, half dead with exhaustion and panting for breath, at the house of a

peasant, just beyond the outskirts of the field. He knocked again and again, but no one came in answer, and so he had to wait for the day to dawn. Shortly after sunrise the people of the house arose, and, hearing the knocking, took the still breathless wanderer into the guest chamber, where they attended to his pitiable state, and then begged him to relate what had befallen him. This he did, and the peasants at once determined to go to the little hut in the field of Inami, which was well known to them. Upon arriving at the spot they found no signs of a burial or of a grave. Mound and coffin had utterly disappeared; but just in front of the hut lay the body of a huge badger, killed by the one cut of the good steel. At once they saw what had happened. The evil beast had wished to frighten the belated wanderer; and the funeral procession and priest, coffin, and grave had been merely the work of magic.

So much for the stories that play such an important *rôle* in the drama of home life in Japan. It is to be regretted that this subject has not been more extensively dealt with in recent writings of the country, for many of the hidden beauties of the country and people are best portrayed in the stories of bygone heroes, as told to the children around the *hibachi*, or as sung by some graceful maiden with *samisen* or *koto* accompaniment; while the tales of ghosts or ghouls rival those of almost any other land in variety and horror.

Turning to the pastimes common to Japanese homes, a brief mention of the most popular games must not be omitted. *Go* and *shogi* are similar to our games of draughts and chess, yet the former is far more scientific than checkers. There are several games of cards, the playing cards being about as long as those used in this country, but scarcely three quarters of an inch wide. Another favorite game is that of "One Hundred Poems." It is somewhat similar to our rather childish game of "Authors," with the exception that the Japanese game is by no means childish, and requires an intimate knowledge of at least one hundred poems of well-known merit. Two hundred cards are used in the game, and half a poem is written on each card. The cards being spread before the players, the half of a poem on any one card is read, and the other half searched for by the contestants. Then the different seasons of the year have typical games. The most picturesque of these is *haguita*, or "battledoor and shuttlecock," which is exclusively a New-Year's game. Then the time of the cherry blooms brings its games beneath the bloom-laden branches. Music and song find their way into the homes of Japan far more extensively than in this country. To be sure, the music of either *koto* or *samisen* is apt to sound strange, and at first perhaps almost unin-

telligible, to our untutored ears; but we soon become familiar with the plaintive notes of the *koto* or the sonorous vibrations of the *samisen*, and learn to both recognize and appreciate the quaint minor harmonies and softly worded melody of some love song, or *so-fu-ren*.

As I have already had occasion to mention, the dramatic or operatic poems are sung with the accompaniment of the *samisen*, while the historical poems, or *utai*, find a musical accompaniment only when recited on the *nō* stage, and then flute and drums are the instruments used. The dramatization of the *utai* upon the *nō* stages is a very ancient custom, and can only be appreciated by the better educated classes. Correctly speaking, *nō* is a his-

FACSIMILE OF A POEM BY ARITSUNÉ.

torical dance, full of weird mysticisms almost unintelligible to those not conversant with its meaning, but its proper performance is a classic art. It has remained unchanged in the slightest detail for centuries, and through its medium the classic historical poetry of the nation is retained and placed before the appreciative public of the higher class.

Thus the drama and history of the country, so full of heroism and romance, shape themselves into poetry and song. The blending of art with poetry is another feature typical of the Japanese people. There are two purely Japanese schools of art: the one dealing with the minutest details, and the other with the bold and forcible portrayal of impressions and suggestions, rather than details; graceful sketches, rather than detailed drawings. "We

can not reproduce Nature in art," a Japanese artist has said, "and instead of making so bold an attempt, had best satisfy ourselves with mere suggestions of Nature's beauties." The same may be said of some Japanese poetry, for the *uta*, or sonnets, usually are mere poetic suggestions of a deeper meaning or sentiment. This brings one to a realization of the close connection between art and poetry in Japan, as also between poetry and music. In social gatherings among friends, a favorite mode for mutual entertainment is for one of the guests to quickly sketch some passing thought or memory of one of Nature's beauties; it may be the crest of some distant mountain, a branch heavy with blossoms, or a flower. This sketch is then passed on to another guest, who, in looking at it, seeks to find some poetic suggestion, or hidden lesson, and having done so, adds the verse to the sketch, and the picture is complete. These illustrated sonnets, the fruits of poetic inspiration and artistic impression, are taken home, to be preserved as cherished souvenirs of the evening's entertainment.

To illustrate this more clearly, we will say that an artist has, with two or three rough strokes of his brush, depicted a bleak mountain peak, with a flock of birds flying above it. This is passed to Aritsuné, a Japanese poet of recognized merit, who after a few moments' thought adds a sonnet to the sketch. It is, like the sketch, a mere suggestion of a deeper sentiment, or *imi*, as the Japanese would have it. I can best render it as follows, making the translation as literal as possible:

We may struggle to the peak
Of the mountain, bare and bleak,
    There but to learn,
    And well discern,
That the winging birds above,
Speeding to their nests of love,
More of Nature's beauties see
    Far than we.

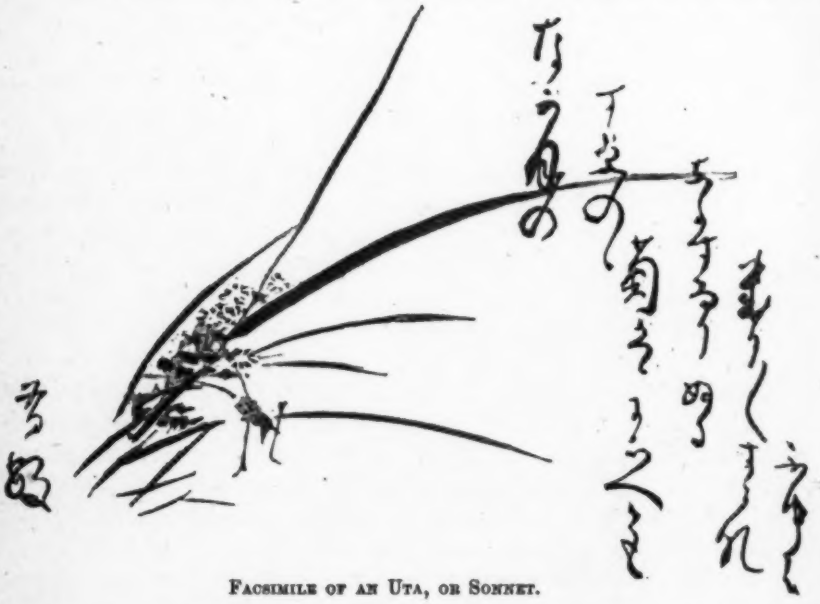
Surely the beauty of the thought is evident, and the deeper meaning, or *imi*, appreciable even to the prosiest of us. Yet in rendering the lesson of the sonnet, as implied to the Japanese reader of the above words, I might add the following lines:

So, when striving naught but fame to obtain,
Thou chance mayst reach the highest peak of earthly gain;
    Then thou wilt learn,
    And well discern,
That Nature doth her beauties wide outspread
For those to daily duties who are wed.
    While simple lives yield peace and light,
    Fame blinds the sight.

One more example of this variety of illustrated verse will suffice, and in the one I have chosen the meaning is confessedly obscure, or at least deep enough to require some thought. The picture, or sketch, is one of a bunch of wild flowers (chrysanthemums), which make their first appearance during the closing days of September, by which time, also, the cheery voice of the locust has been hushed by the increasing cold of the autumn:

Though September's last days are fast ebbing away,
And the locust's bright sonnet is stilled,
Yet the wild flowers fair breathe a far sweeter song
While the air with their fragrance is filled.

In justice it must be confessed that the *imi* of the above lines is rather vague, but may be regarded as a reminder of Nature's kind compensation, for, with the change of seasons, one beauty is



FACSIMILE OF AN UTA, OR SONNET.

scarcely missed before another has filled its place. Perhaps the words may be construed as a gentle reproof to discontented spirits. That the very heart of the nation finds its voice in song is quite evident, for in every instance where a sonnet or poem would find application we are sure to find one. During the time of the cherry and plum blossoms, in early spring, the bloom-laden branches are further ornamented by numerous sonnets inspired by the beauty of the scene—written on strips of white paper, and then made fast to the low-hanging branches. Indeed, the poetic enthusiasm of a score of Orlandos in the forests of Arden would be put to shame. Every season of the year, with the flowers that

it brings, is praised in verse. From the chrysanthemums in autumn, the camellias and plum blossoms of the winter months, the cherry and peach blossoms and wistaria during early spring, the peony in May, and the great lotus flowers during the summer months, so every season has its typical flower, and every flower is loved and praised in song and sonnet by the people. There is room for flowers in the humblest abode, and even the crests of the thatch-roofed huts of the farmers are transformed into miniature gardens of hyacinths and tulips.

So we have pushed aside the latticed doors and glanced in at the Japanese home. True, our stay has been short, and much must be left unnoticed; yet, as we take our reluctant leave, above the soft melody of the *koto* strings, we can clearly hear the lusty chirp of the "cricket on the hearth."

THE INADEQUACY OF "NATURAL SELECTION."

By HERBERT SPENCER.

ALONG with that inadequacy of natural section to explain changes of structure which do not aid life in important ways, alleged in § 166 of The Principles of Biology, a further inadequacy was alleged. It was contended that the relative powers of co-operative parts can not be adjusted solely by survival of the fittest; and especially where the parts are numerous and the co-operation complex. In illustration it was pointed out that immensely developed horns, such as those of the extinct Irish elk, weighing over a hundredweight, could not, with the massive skull bearing them, be carried at the extremity of the outstretched neck without many and great modifications of adjacent bones and muscles of the neck and thorax; and that without strengthening of the fore-legs, too, there would be failure alike in fighting and in locomotion. And it was argued that while we can not assume spontaneous increase of all these parts proportionate to the additional strains, we can not suppose them to increase by variation one at once, without supposing the creature to be disadvantaged by the weight and nutrition of parts that were for the time useless—parts, moreover, which would revert to their original sizes before the other needful variations occurred.

When, in reply to me, it was contended that co-operative parts vary together, I named facts conflicting with this assertion—the fact that the blind crabs of the Kentucky caves have lost their eyes but not the foot-stalks carrying them; the fact that the normal proportion between tongue and beak in certain selected varieties of pigeons is lost; the fact that lack of concomitance in de-

crease of jaws and teeth in sundry kinds of pet dogs, has caused great crowding of the teeth (The Factors of Organic Evolution, pp. 12, 13). And I then argued that if co-operative parts, small in number and so closely associated as these are, do not vary together, it is unwarrantable to allege that co-operative parts which are very numerous and remote from one another vary together. After making this rejoinder I enforced my argument by a further example—that of the giraffe. Tacitly recognizing the truth that the unusual structure of this creature must have been, in its more conspicuous traits, the result of survival of the fittest (since it is absurd to suppose that efforts to reach a high branch could lengthen the legs), I illustrated afresh the obstacles to co-adaptation. Not dwelling on the objection that increase of any components of the fore-quarters out of adjustment to the others would cause evil rather than good, I went on to argue that the co-adaptation of parts required to make the giraffe's structure useful, is much greater than at first appears. This animal has a grotesque gallop, necessitated by the great difference in length between the fore and the hind limbs. I pointed out that the mode of action of the hind limbs shows that the bones and muscles have all been changed in their proportions and adjustments; and I contended that, difficult as it is to believe that all parts of the fore-quarters have been co-adapted by the appropriate variations now of this part, now of that, it becomes impossible to believe that all the parts in the hind-quarters have been simultaneously co-adapted to one another and to all the parts of the fore-quarters: adding that want of co-adaptation, even in a single muscle, would cause fatal results when high speed had to be maintained while escaping from an enemy.

Since this argument, repeated with this fresh illustration, was published in 1886, I have met with nothing to be called a reply; and might, I think, if convictions usually followed proofs, leave the matter as it stands. It is true that, in his Darwinism, Mr. Wallace has adverted to my renewed objection and, as already said, contended that changes such as those instanced can be effected by natural selection, since such changes can be effected by artificial selection: a contention which, as I have pointed out, assumes a parallelism that does not exist. But now, instead of pursuing the argument further along the same line, let me take a somewhat different line.

If there occurs some change in an organ, say, by increase of its size, which adapts it better to the creature's needs, it is admitted that when, as commonly happens, the use of the organ demands the co-operation of other organs, the change in it will generally be of no service unless the co-operative organs are changed. If, for instance, there takes place such a modification

of a rodent's tail as that which, by successive increases, produces the trowel-shaped tail of the beaver, no advantage will be derived unless there also take place certain modifications in the bulks and shapes of the adjacent vertebræ and their attached muscles, as well, probably, as in the hind limbs, enabling them to withstand the reactions of the blows given by the tail. And the question is, by what process these many parts, changed in different degrees, are co-adapted to the new requirements—whether variation and natural selection alone can effect the readjustment. There are three conceivable ways in which the parts may simultaneously change: (1) they may all increase or decrease together in like degrees; (2) they may all simultaneously increase or decrease independently, so as not to maintain their previous proportions or assume any other special proportions; (3) they may vary in such ways and degrees as to make them jointly serviceable for the new end. Let us consider closely these several conceivabilities.

And first of all, what are we to understand by co-operative parts? In a general sense, all the organs of the body are co-operative parts, and are respectively liable to be more or less changed by change in any one. In a narrower sense, more directly relevant to the argument, we may, if we choose to multiply difficulties, take the entire framework of bones and muscles as formed of co-operative parts; for these are so related that any considerable change in the actions of some entails change in the actions of most others. It needs only to observe how, when putting out an effort, there goes, along with a deep breath, an expansion of the chest and a bracing up of the abdomen, to see that various muscles beyond those directly concerned are strained along with them. Or, when suffering from lumbago, an effort to lift a chair will cause an acute consciousness that not the arms only are brought into action, but also the muscles of the back. These cases show how the motor organs are so tied together that altered actions of some implicate others quite remote from them.

But without using the advantage which this interpretation of the words would give, let us take as co-operative organs those which are obviously such—the organs of locomotion. What, then, shall we say of the fore and hind limbs of terrestrial mammals, which co-operate closely and perpetually? Do they vary together? If so, how have there been produced such contrasted structures as that of the kangaroo, with its large hind limbs and small fore limbs, and that of the giraffe, in which the hind limbs are small and the fore limbs large—how does it happen that, descending from the same primitive mammal, these creatures have diverged in the proportions of their limbs in opposite directions? Take, again, the articulate animals. Compare one of the lower types, with its rows of almost equal-sized limbs, and one of the higher

types, as a crab or a lobster, with limbs some very small and some very large. How came this contrast to arise in the course of evolution, if there was the equality of variation supposed?

But now let us narrow the meaning of the phrase still further; giving it a more favorable interpretation. Instead of considering separate limbs as co-operative, let us consider the component parts of the same limb as co-operative, and ask what would result from varying together. It would in that case happen that, though the fore and hind limbs of a mammal might become different in their sizes, they would not become different in their structures. If so, how have there arisen the unlikeness between the hind legs of the kangaroo and those of the elephant? Or if this comparison is objected to, because the creatures belong to the widely different divisions of implacental and placental mammals, take the cases of the rabbit and the elephant, both belonging to the last division. On the hypothesis of evolution these are both derived from the same original form, but the proportions of the parts have become so widely unlike that the corresponding joints are scarcely recognized as such by the unobservant: at what seem corresponding places the legs bend in opposite ways. Equally marked, or more marked, is the parallel fact among the *Articulata*. Take that limb of the lobster which bears the claw and compare it with the corresponding limb in an inferior articulate animal, or the corresponding limb of its near ally, the crayfish, and it becomes obvious that the component segments of the limb have come to bear to one another in the one case proportions immensely different from those they bear in the other case. Undeniably, then, on contemplating the general facts of organic structure, we see that the concomitant variations in the parts of limbs have not been of a kind to produce equal amounts of change in them, but quite the opposite—have been everywhere producing inequalities. Moreover, we are reminded that this production of inequalities among co-operative parts, is an essential principle of development. Had it not been so, there could not have been that progress from homogeneity of structure to heterogeneity of structure which constitutes evolution.

We pass now to the second supposition:—that the variations in co-operative parts occur irregularly, or in such independent ways that they bear no definite relations to one another—miscellaneously, let us say. This is the supposition which best corresponds with the facts. Glances at the faces around yield conspicuous proofs. Many of the muscles of the face and some of the bones, are distinctly co-operative; and these respectively vary in such ways as to produce in each person a different combination. What we see in the face we have reason to believe holds in the limbs as in all other parts. Indeed, it needs but to compare people whose arms are of the same lengths, and observe how stumpy are

the fingers of one and how slender those of another; or it needs but to note the unlikeness of gait of passers-by, implying small unlikenesses of structure; to be convinced that the relations among the variations of co-operative parts are anything but fixed. And now, confining our attention to limbs, let us consider what must happen if, by variations taking place miscellaneously, limbs have to be partially changed from fitness for one function to fitness for another function—have to be re-adapted. That the reader may fully comprehend the argument, he must here have patience while a good many anatomical details are set down.

Let us suppose a species of quadruped of which the members have for long past periods been accustomed to locomotion over a relatively even surface, as, for instance, the "prairie dogs" of North America; and let us suppose that increase of numbers has driven part of them into a region full of obstacles to easy locomotion—covered, say, by the decaying stems of fallen trees, such as one sees in portions of primeval forest. Ability to leap must become a useful trait; and, according to the hypothesis we are considering, this ability will be produced by the selection of favorable variations. What are the variations required? A leap is effected chiefly by the bending of the hind limbs so as to make sharp angles at the joints, and then suddenly straightening them; as any one may see on watching a cat leap on to the table. The first required change, then, is increase of the large extensor muscles, by which the hind limbs are straightened. Their increases must be duly proportioned, for if those which straighten one joint become much stronger than those which straighten the other joint, the result must be collapse of the other joint when the muscles are contracted together. But let us make a large admission, and suppose these muscles to vary together; what further muscular change is next required? In a plantigrade mammal the metatarsal bones chiefly bear the reaction of the leap, though the toes may have a share. In a digitigrade mammal, however, the toes form almost exclusively the fulcrum, and if they are to bear the reaction of a higher leap, the flexor muscles which depress and bend them must be proportionately enlarged; if not, the leap will fail from want of a firm *point d'appui*. Tendons as well as muscles must be modified; and, among others, the many tendons which go to the digits and their phalanges. Stronger muscles and tendons imply greater strains on the joints; and unless these are strengthened, one or other dislocation will be caused by a more powerful spring. Not only the articulations themselves must be so modified as to bear greater stress, but also the numerous ligaments which hold the parts of each in place. Nor can the bodies of the bones remain unstrengthened; for if they have no more than the strengths needed for previous move-

ments they will fail to bear more violent movements. Thus, saying nothing of the required changes in the pelvis as well as in the nerves and blood-vessels, there are, counting bones, muscles, tendons, ligaments, at least fifty different parts in each hind leg which have to be enlarged. Moreover, they have to be enlarged in unlike degrees. The muscles and tendons of the outer toes, for example, need not be added to so much as those of the median toes. Now, throughout their successive stages of growth, all these parts have to be kept fairly well balanced; as any one may infer on remembering sundry of the accidents he has known. Among my own friends I could name one who, when playing lawn-tennis, snapped the Achilles tendon; another who, while swinging his children, tore some of the muscular fibers in the calf of his leg; another who, in getting over a fence, tore a ligament of one knee. Such facts, joined with every one's experience of sprains, show that during the extreme exertions to which limbs are now and then subject, there is a giving way of parts not quite up to the required level of strength. How, then, is this balance to be maintained? Suppose the extensor muscles have all varied appropriately; their variations are useless unless the other co-operative parts have also varied appropriately. Worse than this. Saying nothing of the disadvantage caused by extra weight and cost of nutrition, they will be causes of mischief—causes of derangement to the rest by contracting with undue force. And then, how long will it take for the rest to be brought into adjustment? As Mr. Darwin says concerning domestic animals: "Any particular variation would generally be lost by crossing, reversions etc., . . . unless carefully preserved by man." In a state of nature, then, favorable variations of these muscles would disappear again long before one or a few of the co-operative parts could be appropriately varied, much more before all of them could.

With this insurmountable difficulty goes a difficulty still more insurmountable—if the expression may be allowed. It is not a question of increased sizes of parts only, but of altered shapes of parts, too. A glance at the skeletons of mammals shows how unlike are the forms of the corresponding bones of their limbs; and shows that they have been severally remolded in each species to the different requirements entailed by its different habits. The change from the structures of hind limbs fitted only for walking and trotting to hind limbs fitted also for leaping, implies, therefore, that along with strengthenings of bones there must go alterations in their forms. Now the spontaneous alterations of form which may take place in any bone are countless. How long, then, will it be before there takes place that particular alteration which will make the bone fitter for its new action? And what is the

probability that the many required changes of shape, as well as of size, in bones will each of them be effected before all the others are lost again? If the probabilities against success are incalculable, when we take account only of changes in the size of parts, what shall we say of their incalculableness when differences of form also are taken into account?

"Surely this piling up of difficulties has gone far enough"; the reader will be inclined to say. By no means. There is a difficulty immeasurably transcending those named. We have thus far omitted the second half of the leap, and the provisions to be made for it. After ascent of the animal's body comes descent; and the greater the force with which it is projected up, the greater is the force with which it comes down. Hence, if the supposed creature has undergone such changes in the hind limbs as will enable them to propel it to a greater height, without having undergone any changes in the fore limbs, the result will be that on its descent the fore limbs will give way, and it will come down on its nose. The fore limbs, then, have to be changed simultaneously with the hind. How changed? Contrast the markedly bent hind limbs of a cat with its almost straight fore limbs, or contrast the silence of the upward spring on to the table with the thud which the fore paws make as it jumps off the table. See how unlike the actions of the hind and fore limbs are, and how unlike their structures. In what way, then, is the required co-adaptation to be effected? Even were it a question of relative sizes only, there would be no answer; for facts already given show that we may not assume simultaneous increases of size to take place in the hind and fore limbs; and, indeed, a glance at the various human races, which differ considerably in the ratios of their legs to their arms, shows us this. But it is not simply a question of sizes. To bear the increased shock of descent the fore limbs must be changed throughout in their structures. Like those in the hind limb, the changes must be of many parts in many proportions; and they must be both in sizes and in shapes. More than this. The scapular arch and its attached muscles must also be strengthened and remolded. See, then, the total requirements. We must suppose that by natural selection of miscellaneous variations, the parts of the hind limbs shall be co-adapted to one another, in sizes, shapes, and ratios; that those of the fore limbs shall undergo co-adaptations similar in their complexity, but dissimilar in their kinds; and that the two sets of co-adaptations shall be effected *pari passu*. If, as may be held, the probabilities are millions to one against the first set of changes being achieved, then it may be held that the probabilities are billions to one against the second being simultaneously achieved, in progressive adjustment to the first.

There remains only to notice the third conceivable mode of adjustment. It may be imagined that though, by the natural selection of miscellaneous variations, these adjustments can not be effected, they may nevertheless be made to take place appropriately. How made? To suppose them so made is to suppose that the prescribed end is somewhere recognized; and that the changes are step by step simultaneously proportioned for achieving it—is to suppose a designed production of these changes. In such case, then, we have to fall back in part upon the primitive hypothesis; and if we do this in part, we may as well do it wholly—may as well avowedly return to the doctrine of special creation.

What, then, is the only defensible interpretation? If such modifications of structure produced by modifications of function as we see take place in each individual, are in any measure transmissible to descendants, then all these co-adaptations, from the simplest up to the most complex, are accounted for. In some cases this inheritance of acquired characters suffices by itself to explain the facts; and in other cases it suffices when taken in combination with the selection of favorable variations. An example of the first class is furnished by the change just considered; and an example of the second class is furnished by the case before named of development in a deer's horns. If, by some extra massiveness spontaneously arising, or by formation of an additional "point," an advantage is gained either for attack or defense, then, if the increased muscularity and strengthened structure of the neck and thorax, which wielding of these somewhat heavier horns produces, are in a greater or less degree inherited, and in several successive generations, are by this process brought up to the required extra strength, it becomes possible and advantageous for a further increase of the horns to take place, and a further increase in the apparatus for wielding them, and so on continuously. By such processes only, in which each part gains strength in proportion to function, can co-operative parts be kept in adjustment, and be readjusted to meet new requirements. Close contemplation of the facts impresses me more strongly than ever with the two alternatives—either there has been inheritance of acquired characters, or there has been no evolution.—*Contemporary Review.*

[*To be concluded.*]

In his work on Burma and Farther India, General A. R. MacMahon, ex-Political Resident, expresses the opinion that the caste restriction on social intercourse, the absence of which in Burma gives occasion for much pleasant intimacy with Europeans, has preserved the natives of India from many evils—the result of a too sudden introduction to European ways and habits to which the Burmese succumb.

EVIDENCES OF GLACIAL MAN IN OHIO.

By Prof. G. FREDERICK WRIGHT.

THE recent sweeping denials by Mr. W. H. Holmes, of the Bureau of Ethnology, respecting the validity of the evidence upon which the existence of glacial man in America has been so generally accepted makes it necessary to present the facts in greater detail than has heretofore been done. It seems that Mr. Holmes has been himself looking for palæolithic implements in undisturbed gravel of glacial age for two or three years, but has not found any; and that he has discovered that the Indians had quarries and workshops in various places where they threw aside great piles of partially wrought and rejected implements which were of such shape as not to be readily available for their purposes, and which had a faint resemblance to palæolithic implements. In view of these experiences Mr. Holmes has come to the conclusion, first, that all the so-called palæolithic implements which have been found by Dr. C. C. Abbott and others in America are simply "rejects"; and, secondly, that nobody in America has found any implements in undisturbed gravel of glacial age. In Science for January 20, 1892, he uses the following language: "If there was, as is claimed, an ice-age man, or at any rate a palæolithic man, in eastern America, the evidence so far collected in support of these propositions is so unsatisfactory and in such a state of utter chaos that the investigation must practically begin anew."

The best answer which I can give to this sweeping denial will be to present, with illustrations, the details concerning a single discovery in Ohio with which I am familiar, namely, that at Newcomerstown. But, to get the full significance of this discovery, and the cumulative value of the evidence afforded by it, a brief statement of other discoveries must be made.

The evidence naturally begins with that at Trenton, N. J., where Dr. C. C. Abbott has been so long at work. Dr. Abbott, it is true, is not a professional geologist, but his familiarity with the gravel at Trenton, where he resides, the exceptional opportunities afforded to him for investigation, and the frequent visits of geologists have made him an expert whose opinion is of the highest value upon the question of the undisturbed character of the gravel deposit. The gravel banks which he has examined so long and so carefully have been extensively exposed by the undermining of floods on the river-side, but principally by the excavations which have been made by the railroad and by private parties in search of gravel. For years the railroads had been at work digging away the side of the banks until they had removed

a great many acres of the gravel to a depth of twenty or twenty-five feet. Any one can see that in such conditions there has been no chance for "creep" or landslides to have disturbed the stratification; for the whole area was full of gravel, and there was no chance of disturbance by natural causes. Now, Dr. Abbott's testimony is that up to the year 1888 sixty of the four hundred palæolithic implements which he had found at Trenton had been found at recorded depths in the gravel. Coming down to specifications, he describes in his reports the discovery of one (see Primitive Industry, page 492) found while watching the progress of an ex-

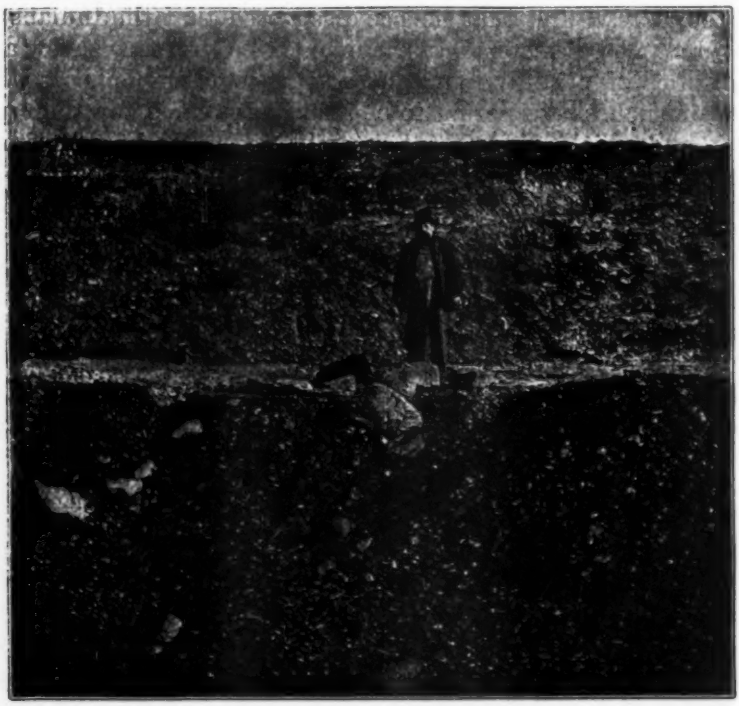


FIG. 1.—SECTION OF THE TRENTON GRAVEL, IN WHICH THE IMPLEMENTS DESCRIBED IN THE TEXT ARE FOUND. The shelf on which the man stands is made in process of excavation. The gravel is the same above and below. (Photograph by Abbott.)

tensive excavation in Centre Street, which was nearly seven feet below the surface, surrounded by a mass of large cobble-stones and bowlders, one of the latter overlying it. Another was found at the bluff at Trenton, in a narrow gorge where the material forming the sides of the chasm had not been displaced, under a large bowlder nine feet below the surface (ibid., page 496). Another was found in a perpendicular exposure of the bluff immediately after the detachment of a large mass of material, and in a surface that had but the day before been exposed, and had not

yet begun to crumble. The specimen was twenty-one feet from the surface of the ground.

In all these and numerous other cases Dr. Abbott's attention was specially directed to the question of the undisturbed character of the gravel, he having been cautioned upon this point in the early part of his investigations.

Here it is proper to premise that the apparent monopoly of this evidence by Prof. Putnam and his associates in the Peabody Museum at Cambridge, Mass., has come about by a legitimate and natural process, which at the same time has probably interfered to a considerable extent with the general spread of the specific information in hand. Early in the investigations at Trenton, Prof. Putnam, who had lately become curator of the museum, with its large fund for prosecuting investigations, satisfied himself of the genuineness of Dr. Abbott's discoveries, and at once retained him as an assistant in the work of the museum, thus diverting to Cambridge all his discoveries at Trenton. Living on the ground during long-continued and extensive excavations made by the railroad, Dr. Abbott's opportunities were exceptionally favorable; hence his own prominence in the whole matter.

It is important also to note that, before taking up with Dr. Abbott's work, Prof. Putnam took ample pains to satisfy himself

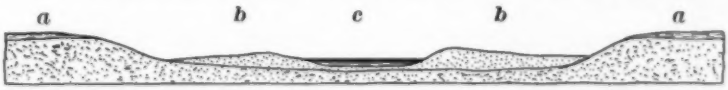


FIG. 2.—SECTION ACROSS THE DELAWARE RIVER AT TRENTON, N. J.: *a*, *a*, Philadelphia red gravel and brick clay (McGee's Columbia deposit); *b*, *b*, Trenton gravel, in which the implements are found; *c*, present flood plain of the Delaware River (after Lewis). (From Abbott's Primitive Industry.)

of its character and correctness. In 1878 Prof. J. D. Whitney visited Trenton in company with Mr. Carr, assistant curator of the museum. In the Twelfth Annual Report Mr. Carr writes: "We were fortunate enough to find several of these implements in place. Prof. Whitney has no doubt as to the antiquity of the drift, and we are both in full accord with Dr. Abbott as to the artificial character of many of these implements." In reporting further upon this instance at the meeting of the Boston Society of Natural History, on January 19, 1881, Mr. Carr states that the circumstances were such that "it [i. e., one of the particular implements] must have been deposited at the time the containing bed was laid down." In 1879, and again in 1880, Prof. Putnam spent some time at Trenton, and succeeded in finding with his own hands "five unquestionable palæolithic implements from the gravel, at various depths and at different points." One of these was four feet below the surface soil and one foot in from the perpendicular face which had just been exposed, and where it was

clear that the gravel had not been disturbed. A second one was eight feet below the surface. (Proc. Boston Soc. of Nat. Hist. for January 19, 1881.)

As confirming the entire trustworthiness of Dr. Abbott's observations, it is to be noted that, with a single exception, all the implements reported below the loam which constitutes the surface soil are of argillite, while those upon the surface, which are innumerable, are chiefly of a different type, made from flint and jasper, or of other material of related character. Another fact, which has always had great weight in my own mind, is one mentioned by the late Prof. Carvill Lewis, in his chapter upon the subject at the end of Dr. Abbott's volume on Primitive Industry. I have the more reason to feel the force of his conclusions, because the proof-sheets passed through Lewis's hands at the time we were together conducting the survey in Pennsylvania, soon after we had visited the deposits in question. The fact was this: Prof. Lewis had been at work for a considerable time in classifying and mapping the gravels in the Delaware Valley, being all the while in ignorance of Dr. Abbott's work until his own results were definitely formulated. But, after he had accurately determined the boundary between the glacial gravels and the far older gravels which surround them and spread over a considerable portion of the territory beyond, he found that the localities where Mr. Carr, Prof. Putnam, and Dr. Abbott had reported finding their implements in undisturbed gravel, all fell within the limits of the glacial gravels, and had in no case been put outside of those limits. Now, Dr. Abbott's house is situated upon the older gravel; but at the time of most of his discoveries he had not learned to distinguish the one gravel from the other. If these implements are all from the surface and had been commingled with lower strata by excavations, landslides, or windfalls, there is no reason why they should not have been found in the older gravels as well as in those of glacial age. There is here a coincidence which is strongly confirmatory of the correctness of our conclusion that there is no mistake in believing that the implements were originally deposited with the gravel where they were found.

Such was the progress of discovery at the time when I began my special investigations upon the glacial boundary in Ohio, and of the glacial terraces there corresponding in age with that at Trenton. To the similarity of conditions along these streams I promptly called attention in 1883, pointing out various places in Ohio where it would be profitable for local observers to be upon the lookout for such evidences of glacial man as had been discovered by Dr. Abbott. The first response to this came from Dr. C. L. Metz, of Madisonville, on the Little Miami River, in southern

Ohio. Dr. Metz is a physician of large practice, of high character, and of long experience as an assistant of Prof. Putnam in exploring the mounds of Ohio. He knows the difference between disturbed and undisturbed gravel as perfectly as any one does. His residence is upon the glacial terrace which borders the Little Miami Valley. In 1885, while digging a cistern in this terrace, a perfectly formed implement of black chert was found by him in undisturbed gravel eight feet below the surface. This was exhibited by Prof. Putnam at a meeting of the Boston Society of Natural History, on the 4th of November, 1885, and is No. 40,970 in the Peabody Museum. Two other implements were discovered at a later time by Dr. Metz in the talus of the glacial terrace of the Little Miami, at Loveland, where also numerous bones of the

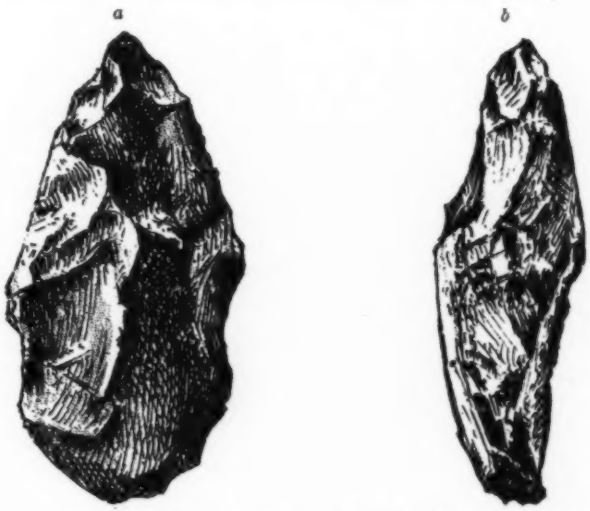


FIG. 3.—CHIPPED PEBBLE OF BLACK CHERT, found by Dr. C. L. Metz, October, 1885, at Madisonville, Ohio, in gravel eight feet from surface under clay: *a*, face view; *b*, side view. Natural size.

mammoth were found. But, as these were not in place when discovered, they can not be adduced as positive evidence.

The discovery at Newcomerstown, of which Messrs. Holmes, Brinton, and McGee speak so lightly because they do not know the facts, is really one of the best attested of all the single cases. The discovery was made in 1889 by Mr. W. C. Mills. The implement has been presented to the Western Reserve Historical Society of Cleveland, and can there be seen at any time in company with various implements from France. A photogravure from it appears in the smaller figure in the following cut.

The discovery of the implement was made in October, but it was not brought to public notice until the next spring, when I chanced to meet Mr. Mills and learned about it. He then for-

warded it to me, when its exact resemblance in form and finishing to an implement which I have in my own collection, that was obtained by Dr. Evans, of London, at Amiens, France, greatly impressed me. I forwarded it immediately to Prof. H. W. Haynes,

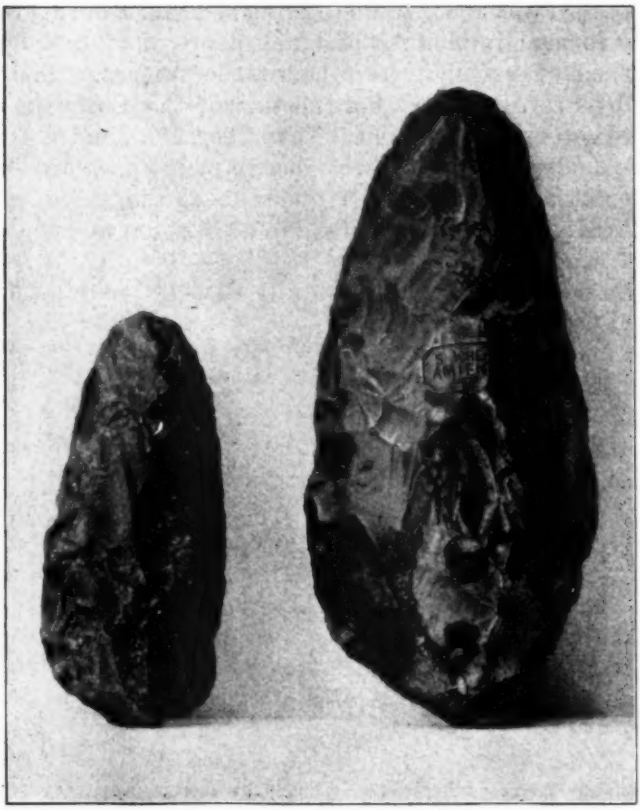


FIG. 4.—THE SMALLER IS THE PALÆOLITH FROM NEWCOMERSTOWN, THE LARGER FROM AMIENS, FRANCE (face view). Reduced one half in diameter.

of Boston, whose expert judgment is second to that of no other person in America, or indeed of the world. Prof. Haynes exhibited it at the meeting of the Boston Society of Natural History on May 7, 1890, and his account was published in the Proceedings of that evening. In conclusion, after having enumerated its distinctive characteristics, he said, "I desire to express most emphatically my belief in the genuineness and age of this Newcomerstown implement, as well as to call attention to the close resemblance in all particulars which it bears to these unquestioned palæolithic implements [which he exhibited beside it] of the Old World." This implement is not a "reject," but is a finished implement, with the secondary chippings all around the edge. The

cuts, reproduced from photographs, perfect as they are, by no means do it justice.

I promptly gave an account of this discovery in The Nation, in its issue for April 24, 1890, and repeated it in substance with some additional particulars on page 620 of the third edition of my volume on The Ice Age in North America. This account was also reprinted in The Popular Science Monthly, Volume XXXIX, pages 314 to 319. The account in my later volume, on Man and the Glacial Period, is still more condensed. The more detailed evidence is published in Tract No. 75 of the Western Reserve Historical Society, Cleveland, Ohio, containing the report of the meet-

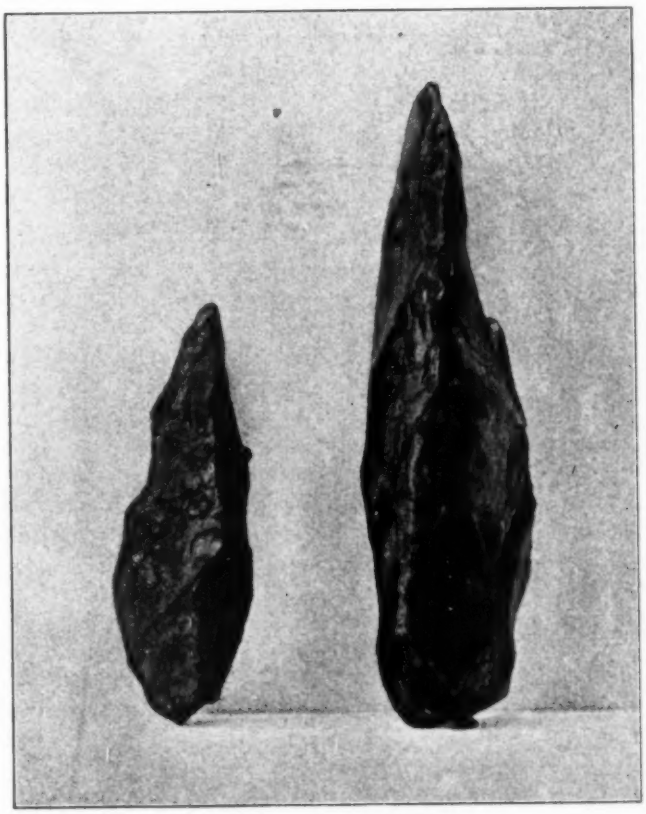


FIG. 5.—EDGE VIEW OF THE PRECEDING

ing when Mr. Mills was present and gave his own testimony. This was held December 12, 1890.

The facts are these: There is a glacial gravel terrace in Newcomerstown at the mouth of Buckhorn Creek, where it enters the larger valley of the Tuscarawas River. There can be no question about the glacial age of this terrace. It is continuous up the

river to the terminal moraine. Its surface is about thirty-five feet above the flood-plain of the Tuscarawas; it consists of stratified material, containing many granitic pebbles and much granitic gravel. The deposit at Newcomerstown extends over many acres, having been protected from erosion in the recess at the

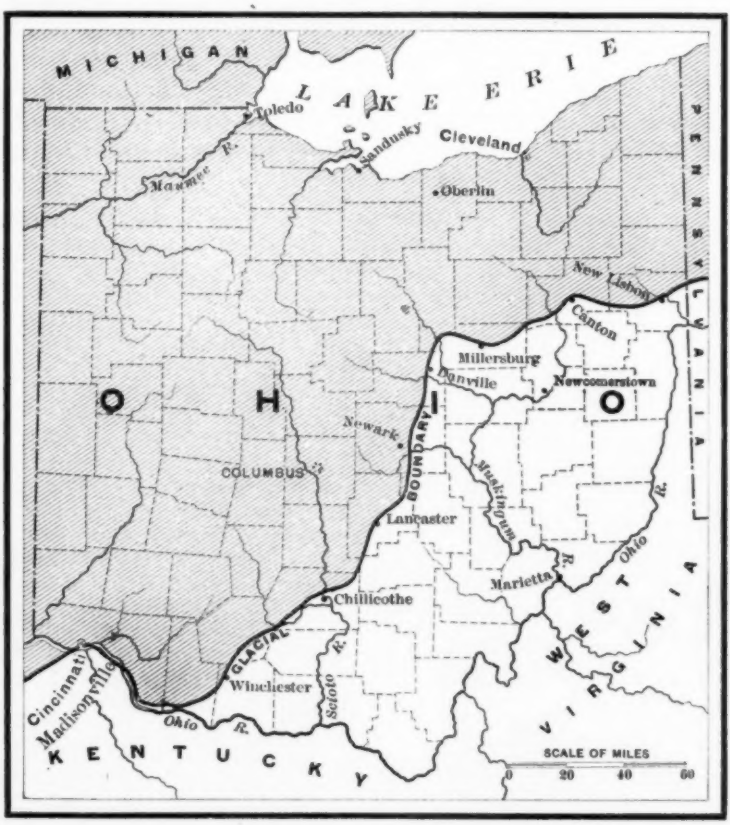


FIG. 6.

mouth of Buckhorn Creek. Through the middle of this deposit the railroad had cut its road-bed, and for years has been appropriating the gravel for ballast.

Mr. Mills is an educated business man, who had been a pupil in geology of Prof. Orton, of the State University, and had with him done considerable field-work in geology. Mr. Mills's character and reputation are entirely above suspicion. In addition to his business he took a laudable interest in the collection of Indian relics, and had in his office thousands of flint implements, collected by him and his associates in the vicinity, who had been organized into an archæological society. His office was but a short distance from the gravel pit from which I have said the

railroad had been for so many years obtaining ballast. The perpendicular face of this bank of gravel as it was exposed from time to time by the excavations of the railroad men was frequently examined by Mr. Mills, not with special reference to finding implements, for that thought had not entered his mind, but for the sake of obtaining specimens of coral, which occasionally occurred in the gravel. While engaged in one of these rounds, on the 27th of October, 1889, he found this specimen projecting from a fresh exposure of the perpendicular bank, fifteen feet below the surface, and, according to his custom, recorded the facts at the time in his note-book. There was no lack of discrimination in his observations, or of distinctness in his memory.

The accompanying illustration from a photograph taken six months after the discovery, and when a talus consequent upon the frosts of winter had accumulated to a considerable extent at

FIG. 7.—TERRACE IN NEWCOMERSTOWN, SHOWING WHERE W. C. MILLS FOUND A PALÆOLITHIC IMPLEMENT.

the base of the deposit, shows the spot in the bank from which the implement was taken. In looking for objects of his quest, Mr. Mills thrust in his cane into the coarser gravel which is seen to overlie the finer deposits. This resulted in detaching a large mass about six feet long and two feet wide, which fell down at his

feet. It was in the face of the bank behind this mass that Mr. Mills's eye, so long trained for the detection of artificially chipped flints, discovered the implement under consideration, which he removed with his own hands, and placed in his collection, with little thought at the time of the significance attaching to the position in which it was found. The accompanying map of the vicinity and drawing of the bank were made by Mr. Mills at the time of our visit, and furnish, with the photograph, all the additional information necessary.

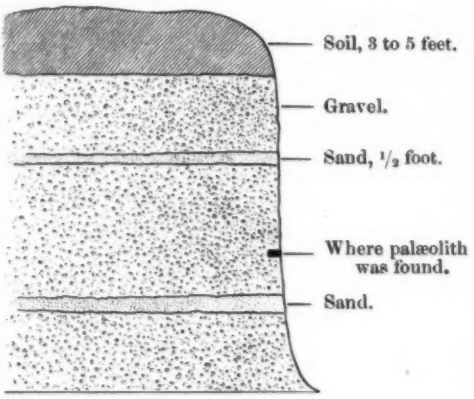


FIG. 8.

There is no possibility of mistake concerning the undisturbed character of the gravel from which Mr. Mills took the implement. All the strata were clearly exposed and observed by him.

These facts, submitted at the meeting of the Western Reserve Historical Society referred to, were fully detailed upon the spot

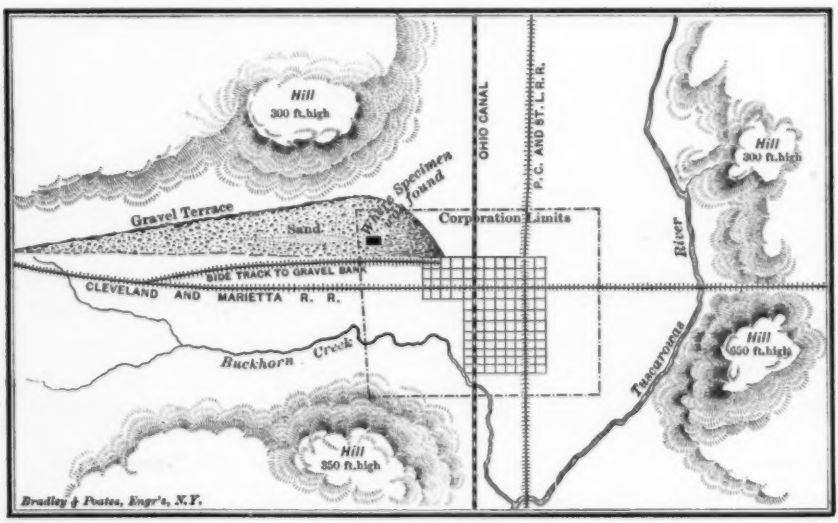


FIG. 9.—Height of Terrace exposed, 25 feet. Palæolith was found 14¾ feet from surface.

to myself and a party of gentlemen, consisting of Judge C. C. Baldwin, E. A. Angell, Esq., William Cushing, Esq., all lawyers of eminence, and Mr. David Baldwin, who accompanied me in a

visit to the place on the 11th of April, 1890. We had all the opportunity to question and cross-question that could be desired.

In conclusion, it is proper to say that the sweeping character and the suddenness of these attacks of Mr. Holmes and his associates upon the evidence of glacial man in America have been somewhat bewildering. It has come like thunder from a clear sky. One has but to go back to Mr. McGee's article in The Popular Science Monthly for November, 1888, to find an unquestioning and enthusiastic indorsement of nearly all the facts concerning glacial man which I have incorporated in my recent volume upon Man and the Glacial Period, together with a number which I have omitted, except the discovery at Newcomerstown, which had not then been made. Had I been aware of the preparations which these investigators were making to discredit all past observers on the matter, I should have introduced more detailed evidence in my summary in the volume referred to. Still, it is probably as well that the statements were left as they are, for they are all capable of ample proof; and it is perhaps better for the public to be referred for details to such fuller reports as are made in this article and in the other publications here indicated.

I submit that this evidence is neither "chaotic" nor "unsatisfactory," but is as specific and definite and as worthy to be believed as almost anything any expert in this country, or any other country, can be expected to produce.

GROWTH OF OUR KNOWLEDGE OF THE DEEP SEA.

By G. W. LITTLEHALES,
CHIEF OF THE DIVISION OF CHART CONSTRUCTION, UNITED STATES HYDROGRAPHIC OFFICE.

BEFORE the time of the project for the Atlantic telegraph cable in 1854, there seemed to be no practical value attached to a knowledge of the depths of the sea, and, beyond a few doubtful results obtained for purely scientific purposes, nothing was clearly known of bathymetry, or of the geology of the sea bottom. The advent of submarine cables gave rise to the necessity for an accurate knowledge of the bed of the ocean where they were laid, and lent a stimulus to all forms of deep-sea investigation. But although our extensive and accurate knowledge of the deep sea is of so late an origin, the beginnings of deep-sea research date far back into antiquity. The ancients can not be said to have had any definite conceptions of the deep sea. Experienced mariners, like the Phœnicians and Carthaginians, must necessarily have possessed some knowledge of the depths of the waters with which they were familiar, but this knowledge, whatever its extent, has

now passed away. To the writings of Aristotle, who lived during the fourth century B. C., are credited the first bathymetric data. He states that the Black Sea has whirlpools so deep that the lead has never reached the bottom; that the Black Sea is deeper than the Sea of Azov, that the Ægean is deeper than the Black Sea, and that the Tyrrhenian and Sardinian Seas are deeper than all the others. The first record of a deep-sea sounding should be credited to Posidonius, who stated, about a century B. C., that the sea about Sardinia had been sounded to a depth of one thousand fathoms. No account is given of the manner in which the sounding was taken, and we have no information as to the methods employed by the ancients in these bathymetric measurements.

The opinions of the learned with respect to the greatest depth of the sea, in the first and second centuries A. D., may be gleaned from the writings of Plutarch and Cleomedes, the first of whom says, "The geometers think that no mountain exceeds ten stadia [about one geographic mile] in height, and no sea ten stadia in depth." And the second: "Those who doubt the sphericity of the earth on account of the hollows of the sea and the elevation of the mountains, are mistaken. There does not, in fact, exist a mountain higher than fifteen stadia, and that is also the depth of the ocean."

There was no important addition to our knowledge of the deep sea during the middle ages, and no definite attempt to provide effective means for deep-sea sounding appears to have been made until Nicolaus Causanus, who lived in the first half of the fifteenth century, invented an apparatus consisting of a hollow sphere, to which a weight was attached by means of a hook, intended to carry the sphere down through the water with a certain velocity. On touching the ground the weight became detached and the sphere ascended alone. The depth was calculated from the time the sphere was under water. This apparatus was afterward modified by Plücher and Alberti, and, in the seventeenth century, by Hooke, who substituted a piece of light wood well varnished over for the hollow sphere. Hooke's instrument was no doubt fairly accurate in shallow water, but useless in great depths, where the enormous pressure waterlogged the wood and, by materially increasing its density, greatly diminished the speed with which it rose from the bottom. When used in currents the float was carried away and the record lost.

During the period when the voyages of Columbus, Vasco da Gama, and Magellan added a hemisphere to the chart of the world and forever established the fundamental principles of all scientific geography, navigators had sounding lines of one hundred and two hundred fathoms in length, and, although they eagerly studied the oceanic phenomena revealed at the surface, the deep sea did not

engage their attention. Kircher, in his Mundus Subterraneus, gives the ideas as to the depths of the sea that were accepted in the first half of the seventeenth century, stating that "in the same manner as the highest mountains are grouped in the center of the land, so also should the greatest depths be found in the middle of the largest oceans; near the coasts with but slight elevations the depth will gradually diminish toward the shore. I say coasts with but slight elevations, for, if the shores are surrounded by high rocks, then greater depths are found. This is proved by experience on the shores of Norway, Iceland, and the islands of Flanders."

Several soundings were taken in deep water during the eighteenth century, but they were not of much value. The first at all reliable were made by Sir John Ross during his well-known arctic expedition in 1818. He brought up six pounds of mud from 1,050 fathoms in Baffin Bay, and obtained correct soundings in 1,000 fathoms in Possession Bay, finding worms and other animals in the mud procured. Sir James Clark Ross, during his antarctic expedition from 1839 to 1843, obtained satisfactory soundings of 2,425 and 2,677 fathoms in the South Atlantic, with a hempen cord. He also dredged successfully in depths of 400 fathoms.

Meanwhile, about the middle of the eighteenth century, the first definite ideas about the formation of the bottom soil began to be advanced, although there had been speculations on the formation of alluvial layers since the time of Herodotus. In 1725 Marsilli made a few observations on the bathymetric knowledge then possessed concerning the nature of the bottom of the sea. He admitted that the basin of the sea was excavated "at the time of the creation out of the same stone which we see in the strata of the earth, with the same interstices of clay to bind them together," and pointed out that we should not judge of the nature of the bottom of the basins by the materials which seamen bring up in their soundings. The dredgings almost always indicate a muddy bottom, and very rarely a rocky one, because the latter is covered with slime, sand, and sandy, earthy, and calcareous concretions, and organic matter. These substances, he said, conceal the real bottom of the sea, and have been brought there by the action of the water. Lastly, by way of explanation, he compared the bed of the sea to the inside of an old wine cask, which seems to be made of dregs of tartar although it is really of wood.

Donati's studies on the bottom of the Adriatic Sea led him to announce, about the middle of the eighteenth century, that it is hardly different from the surface of the land, and is but a prolongation of the superposed strata in the neighboring continent, the strata themselves being in the same order. The bottom of this sea is, according to him, covered with a layer formed by crusta-

ceans, testaceans, and polyps, mixed with sand, and to a great extent petrified. This crust may be seven or eight feet deep, and he attributed to this deposit, bound together with the remains of organisms and sedimentary mineral matter, the rising of the bottom of the sea, and the encroachment of the water on the coasts.

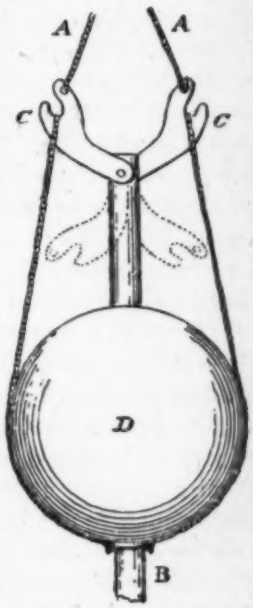
In 1836 Ehrenberg produced the first of a long series of publications relating to microscopic organisms which distinguished him as a naturalist of rare sagacity. He devoted the whole of his life to the study of microscopic organisms, to the examination of materials brought up from deep-sea soundings, and to all questions appertaining to the sea. Having discovered that the siliceous strata known as tripoli, found in various parts of the globe, are but accumulations of the skeletons of diatoms, sponges, and radiolaria, and having found living diatoms and radiolaria on the surface of the Baltic of the same species as those found in the Tertiary deposits of Sicily, and having shown that in the diatom layers of Bilin in Bohemia the siliceous deposit had, under the influence of infiltrated water, been transformed into compact opaline masses, he concluded that rocks like those which play so important a part in the terrestrial crust are still being formed on the bottom of the sea.

The investigation of the distribution of marine animals according to the depths of the sea may be said to have commenced in 1840 with Forbes's studies in the Mediterranean. He maintained that the dredgings showed the existence of distinct regions at successive depths, having each a special association of species; and remarks that the species found at the greatest depths are also found on the coast of England—concluding, therefore, that such species have a wider geographical distribution. He divided the whole range of depth occupied by marine animals into eight zones, in which animal life gradually diminished with increase of depth, until a zero was reached at about three hundred fathoms. He also supposed that plants, like animals, disappeared at a certain depth, the zero of vegetable life being at a less depth than that of animal life.

It has already been mentioned that probably the first reliable deep-sea soundings ever made were by Sir John Ross in 1818. To him is due the invention of the so-called deep-sea clam, by means of which specimens of the bottom were for the first time brought up from great depths in any quantity. This instrument was in the form of a pair of spoon-forceps, kept apart while descending, but closed by a falling weight on striking the bottom. Two separate casts were usually made, one to ascertain the depth and the other to bring up a specimen of the bottom soil.

For the development of accurate knowledge of the depths of the sea the world will ever be indebted to the genius of Midship-

man Brooke, of the United States Navy, who made the first great improvement in deep-sea sounding in 1854 by inventing a machine in which, applying Causanus's idea of disengaging a weight attached to the sounding line, the sinker was detached on striking the bottom and left behind when the tube was drawn up. The arrangement of the parts is shown in the accompanying figure. When the tube B strikes the bottom, the lines A A slack and allow the arms C C to be pulled down by the weight D. When these arms have reached the positions indicated by the dotted lines, the slings supporting the weight have slipped off, and the tube can be hauled up, bringing within it a specimen of the bottom. This implement has been improved from time to time by various officers of our own and foreign navies by changing the manner of slinging and detaching the sinker, and by adding valves to the upper and lower ends of the tube to prevent the specimen from being washed out during the rapid ascent which has been rendered possible by the use of wire sounding line and steam hoisting engines; but in all the essential features it is the same as the most successful modern sounding apparatus. The impulse given to deep-sea sounding by Brooke was seconded by the successful adaptation of pianoforte wire to use as a sounding line, in 1872, by Sir William Thomson; and within recent years soundings have been taken far and wide in all the seas by national vessels during their cruises, by vessels engaged in laying submarine cables, and by various specially organized expeditions, among which that known as the Challenger Expedition, sent out by the Government of Great Britain during the period from 1873 to 1876, stands pre-eminent. As a result of this work many of the questions which perplexed the naturalists of the middle of the present century have now been cleared away.



Many of the specimens of the bottom that were brought up in the early days of deep-sea sounding were studied through the microscopes of Ehrenberg, of Berlin, and Bailey, of West Point. Maury, who believed that there are no currents and no life at the bottom of the sea, wrote: "They all tell the same story. They teach us that the quiet of the grave reigns everywhere in the profound depths of the ocean; that the repose there is beyond the reach of wind; it is so perfect that none of the powers of earth, save only the earthquake and volcano can disturb it. The

specimens of deep-sea soundings are as pure and as free from the sand of the sea as the snowflake that falls when it is calm upon the lea is from the dust of the earth. Indeed, these soundings suggest the idea that the sea, like the snow cloud with its flakes in a calm, is always letting fall upon its bed showers of these microscopic shells; and we may readily imagine that the 'sunless wrecks' which strew its bottom are, in the process of ages, hid under this fleecy covering, presenting the rounded appearance which is seen over the body of a traveler who has perished in the snowstorm. The ocean, especially within and near the tropics, swarms with life. The remains of its myriads of moving things are conveyed by currents, and scattered and lodged in the course of time all over its bottom. The process, continued for ages, has covered the depths of the ocean as with a mantle, consisting of organisms as delicate as the macled frost and as light as the undrifted snowflake of the mountain."

Maury was right in respect to the covering of the bed of the deep sea, for, as a result of all our researches, it is found that in waters removed from the land and more than fourteen hundred fathoms in depth there is an almost unbroken layer of pteropod, globigerina, diatom, and radiolarian oozes, and red clay which occupies nearly 115,000,000 of the 143,000,000 square miles of the water surface of the globe. But he was wrong in asserting that low temperature, pressure, and the absence of light preclude the possibility of life in very deep water.

Ehrenberg held the opposite opinion with regard to the conditions of life at the bottom of the sea, as may be seen from the following extract from a letter which he wrote to Maury in 1857: "The other argument for life in the deep which I have established is the surprising quantity of new forms which are wanting in other parts of the sea. If the bottom were nothing but the sediment of the troubled sea, like the fall of snow in the air, and if the biolithic curves of the bottom were nothing else than the product of the currents of the sea which heap up the flakes, similarly to the glaciers, there would *necessarily* be much less of unknown and peculiar forms in the depths. The surface and the borders of the sea are much more productive and much more extended than the depths; hence the forms peculiar to the depths should not be perceived. The great quantity of peculiar forms and of soft bodies existing in the innumerable carapaces, accompanied by the observation of the number of unknowns, *increasing with the depth*—these are the arguments which seem to me to hold firmly to the opinion of stationary life at the bottom of the deep sea."

It would appear to have been definitely established by the researches of the last fifty years that life in some of its many forms is universally distributed throughout the ocean. Not only in the

shallower waters near coasts, but even in the greater depths of all oceans, animal life is exceedingly abundant. A trawling in a depth of over a mile yielded two hundred specimens of animals belonging to seventy-nine species and fifty-five genera. A trawling in a depth of about three miles yielded over fifty specimens belonging to twenty-seven species and twenty-five genera. Even in depths of four miles fishes and animals belonging to all the chief invertebrate groups have been procured, and in a sample of ooze from nearly five miles and a quarter there was evidence to the naturalists of the Challenger that living creatures could exist at that depth.

Recent oceanographic researches have also established beyond doubt that while in great depths the water is not subjected to the influence of superficial movements like waves, tides, and swift currents, there is an extremely slow movement, in striking contrast with the agitation of the surface water. Although the movement at the bottom is so slow that the ordinary means of measuring currents can not be applied accurately to them, the thermometer furnishes an indirect means of ascertaining their existence. Water is a very bad conductor of heat, and consequently a body of water at a given temperature passing into a region where the temperature conditions are different retains for a long time, and without much change, its original temperature. To illustrate: The bottom temperature near Fernando do Noronha, almost under the equator, is 0·2° C., or close upon the freezing point; it is obvious that this temperature was not acquired at the equator, where the mean annual temperature of the surface layer of the water is 21° C., and the mean normal temperature of the crust of the earth not lower than 8° C. The water must therefore have come from a place where the conditions were such as to give it a freezing temperature; and not only must it have come from such a place, but the supply must be continually renewed, however slowly, for otherwise its temperature would gradually rise by conduction and mixture. Across the whole of the North Atlantic the bottom temperature is considerably higher, so that the cold water can not be coming from that direction; on the other hand, we can trace a band of water at a like temperature at nearly the same depth continuously to the Antarctic Sea, where the conditions are normally such as to impart to it this low temperature. There seems, therefore, to be no doubt that there is a current from the antarctic to the equator along the bottom of the South Atlantic.

From the millions of reliable deep-sea soundings that have been made during the last forty years the more general features of the bathymetric chart of the world have been firmly established; and the ancient idea, derived chiefly from a supposed

physical relation, that the depths of the sea are about equal to the heights of the mountains, has given place to exact notions as to the depths as well as the heights.

The greatest known depths that have been reliably sounded in the different oceans are given in the following list:

	Latitude.	Longitude.	Depth in fathoms.
North Atlantic Ocean	19° 39′ N.	66° 26′ W.	4,561
South Atlantic Ocean	19° 55′ S.	24° 50′ W.	3,284
North Sea (Skagerack)	58° 12′ N.	9° 30′ E.	442
Baltic Sea	58° 37′ N.	18° 30′ E.	233
Mediterranean Sea	35° 45′ N.	21° 46′ E.	2,405
Black Sea	42° 55′ N.	33° 18′ E.	1,431
Caribbean Sea	19° 0′ N.	81° 10′ W.	3,427
Indian Ocean	11° 22′ S.	116° 50′ E.	3,393
North Pacific Ocean	44° 55′ N.	152° 26′ E.	4,655
South Pacific Ocean	24° 37′ S.	175° 08′ W.	4,428
Bering Sea	54° 30′ N.	175° 32′ W.	2,146
Sea of Japan	38° 30′ N.	135° 0′ N.	1,640
China Sea	17° 15′ N.	118° 50′ E.	2,350
Sulu Sea	8° 32′ N.	121° 55′ E.	2,549
Celebes Sea	4° 16′ N.	124° 02′ E.	2,794
Banda Sea	5° 24′ S.	130° 37′ E.	2,799
Flores Sea	7° 43′ S.	120° 26′ E.	2,799
Arctic Ocean	78° 05′ N.	2° 30′ W.	2,469
Antarctic Ocean	62° 26′ S.	95° 44′ E.	1,975

THE CULTIVATION OF HUMANE IDEAS AND FEELINGS.*

By Prof. WESLEY MILLS, M. A., M. D.,
MC GILL UNIVERSITY, MONTREAL.

THE main object of every society for the prevention of cruelty to animals I take to be the establishment of right feelings toward our speechless fellow-creatures. But feeling, to be correct, strong, and abiding, must be based on sound conceptions of the nature of that toward which it is exercised. So long as any individual believes that another wishes to injure him, so long will he find it most difficult to entertain kindly feelings toward the man that he deems his enemy; but let it appear that he has entirely misunderstood the motive and actions of the individual in question—that instead of an enemy he proves to be a friend—and the whole current of feeling is changed. Thus would it be, in my opinion, with thousands of people if they could be made to see animals in their true light.

Glancing at historical and national views of animal life, we find at all periods widely different conceptions, and consequently

* An Address before the American Humane Association, Philadelphia, October 27, 1892.

feelings, in regard to some of our domestic animals. A certain animal regarded as a fit subject for contempt by some peoples has been an object of worship, or something akin to it, by others; hence it is not surprising that the lot of such animals has been very different in some parts of the world as compared with others. To illustrate this we need go no further than the universally distributed dog and cat. In the East the dog is rarely other than a homeless, despised outcast. In Europe generally he is a member of the family. But it is to Great Britain especially that we look to find all our domestic animals in the highest perfection, and cherished with feelings of peculiar regard. In Britain it is contrary to law to hitch a dog, however large and strong, to a cart to draw even a small child, while in Germany dogs may be seen used as beasts of burden in all the large cities. In no part of the world are the good qualities of dogs so appreciated and valued as in Great Britain; hence it is not at all inexplicable that cruelty to the dog and other animals is there comparatively rare.

It may safely be said that never before in civilized countries were animals—and especially our domestic animals—treated so well, because never before were they so thoroughly understood. To what is this to be attributed? Not alone to the spread of kindlier feelings and better principles generally, but largely to the advance of science. There was a time, well within the recollection of persons not yet old, when man, we were told by those to whom we looked for light and guidance, stood utterly apart from all else in the universe as the one being in whom the Creator specially, and we might say solely, delighted, and for whose benefit every other object, animate and inanimate, existed. How natural, then, for man to believe that animals, as such, had few if any rights!

The one test to which many persons naturally enough brought every animal was just this: Is the creature of any *use* whatever to man? If not, then it was held that it simply cumbered the ground. People, it is true, admitted that man was an animal; but they did not realize what this expression meant, or did not accept it in its full significance. To them man was an "animal," but not like the others. He was too exalted to have any more than the common principle of life. Men could not realize then as now that mind and body are so closely related that for every mental process there must be a corresponding physical correlative. But this once being admitted it became possible to understand that animals below man may have minds whose processes are akin to ours. The question then became, not have animals minds, but what sort of minds. Wherein does animal intelligence in the widest sense differ from human intelligence? As soon as man himself became better understood it was plain that his feelings were, on certain

planes, parallel with groups of animals much lower in the scale generally. To them pleasures and pains were just as real as they were similar to those of human beings.

I suggest that these most important advances are owing chiefly to the progress and the diffusion of scientific knowledge and the scientific spirit. The doctrine of organic evolution published by Darwin over thirty years ago at once offered to man a broader kinship than he had previously been able to comprehend. In my opinion the importance of this conception will, for a right understanding of the relations of man and other animals, outweigh all others, because it will bring us to see that, with a common origin, there must always remain numerous similarities of nature.

But, without taking advantage of the doctrine of evolution, it has become apparent that the claim for man of a nature entirely distinct and different from that of other forms of life is baseless. Gradually, from many different quarters, this conception of similarity of nature is spreading among the masses; and the friend of animals can not do better than encourage people to dwell upon the resemblances rather than the differences between the highest and the lower grades of animal life. It will be readily perceived, then, that my conviction is that we shall best advance the cause we have at heart—the humane treatment of our animals—by spreading sound views of their nature, and in that keeping prominent the resemblances to man rather than the differences from him, many of them questionable, at all events as to kind.

Inasmuch as science has done more than all other agencies in dissipating man's prejudices and freeing the mind from erroneous and enslaving views, it will be wise for all societies with a humane object to think well before in any way interfering with scientific investigations of any kind. Without research the true nature of those diseases which afflict man and the lower animals can not be known.

With many persons dogs and hydrophobia are closely associated mentally, and I recently read an article in which the author spoke of the dog as the "breeder of hydrophobia." The societies will do good by publishing actual statistics and other details bearing on the nature of this dreaded disease. I have also read arguments for the complete extirpation of dogs based on the fact that some sheep were worried. The plain preventive for rabies is the proper care and management of dogs; and for sheep-worrying, the confinement of dogs at night, which would be, indeed, a proper proceeding if no sheep existed. A roaming dog is no more desirable than a human tramp; but no one has advocated the destruction of the human race to get rid of tramps. In attempting to spread sound views in regard to diseases that are common to man and our domestic animals, such as rabies, indirectly much

information will be given to the public about the care of dogs, with a view to avoiding conditions that simulate this terrible malady. The "mad dog" of the streets is, we know, rarely rabid, and usually only needs a little judicious and kindly assistance to restore him to health. It is just about as reasonable to pounce on and kill a human being that falls in an epileptic fit, as the majority of the dogs that are attacked and killed by an excited crowd.

Above all, the public needs enlightenment regarding the true nature of animals. When that is complete and thorough, right feelings toward them will spring up in the larger proportion of people. I would especially direct attention to the education of children in and out of school on this subject. It should be held before a child as a more cowardly thing to abuse a defenseless animal than one of its own species. But this will not weigh much with the child if all it hears tends to belittle the creatures by which it is surrounded, and to exalt man beyond all measure. I should begin with very young children by pointing to similarities of structure and function between themselves and the family cat or dog. They have eyes, ears, tongues, etc.; they see, hear, taste, feel pain, and experience pleasure just as children do; therefore, let us recognize their rights, avoid giving them pain, and increase their pleasures. I strongly advocate each family having some one animal, at least, to be brought up with the household to some extent, whether it be bird, cat, or dog. But, on the other hand, it seems to me to be a great mistake to introduce any animal as a mere toy or plaything for very young children. Such a proceeding rather tends to encourage cruelty.

It is of great importance for the education of the public mind that fine specimens of animals be exhibited. All shows for our domestic animals are worthy of encouragement as educators. Many a person that regards the ordinary mongrel dogs of the street with indifference, if not aversion, has his views and feelings changed when he attends a dog show, with its numerous specimens of fine, pure-bred animals; and the same may be said of horse, cattle, and poultry shows. The æsthetic has a very great influence in our age. We devote a large share of our energies to securing the gratification of our sense of the beautiful. It will be judicious, therefore, to present the beautiful in animals to the public. For this reason, again, exhibitions of superior specimens of domestic animals, zoölogical gardens, museums, and kindred institutions prepare the public mind to appreciate animals more; and, as I am endeavoring to show, to understand and to admire are usually necessary steps to the generation of humane feelings toward the creatures with which we come in contact.

Once establish the proper feelings, and fitting conduct is likely to follow; but before these feelings arise we must have right con-

ceptions of man's relations, if not relationship, to the animal kingdom.

While many persons are ready to admit that, so far as physical organization is concerned, man and other animals are on the one plane, they either do not believe in any likeness beyond this, or more probably they have never examined the subject.

It is not unlikely that the great majority of persons have not devoted a half hour of their lives, taken altogether, to any thought upon such a subject. It has been taken for granted that man is on one plane of intellect and feeling, and all other animals are so much below him that their acts are not commonly regarded as other than the result of instinct, a sort of blind impulse, so that they are not regarded as showing at all those qualities which we term mental, much less moral ones. Even educated persons have but vague conceptions on the subject of animal intelligence. The publications of many of the humane societies bearing on animal intelligence must have done a vast amount of good in dissipating ignorance and prejudice.

We have in Montreal, in connection with the Faculty of Comparative Medicine and Veterinary Science of McGill University, a society for the study of comparative psychology—the only institution of the kind with which I am acquainted. It has been in existence now six years.

A brief account of the proceedings of each meeting is published in the daily press of the city, and I have reason to believe that the association has in this way alone helped considerably the cause of the lower animals. The Montreal Association for the Prevention of Cruelty to Animals has received and circulated large numbers of copies of several of the papers read before this society for the study of animal intelligence.

I suggest that if the interest of teachers—especially the heads of schools—can be secured, some steps may be taken in leading the young to entertain correct views and feelings toward the lower animals. The keynote should be: They are our fellow-creatures; in some, but not all respects, our "poor relations"; to be guarded and assisted, but also to be respected; for in not a few directions they are superior to ourselves. Let this spirit get into schools and families, and but little actual formal teaching will be required to accomplish the end in view. Actions on the part of elders in this, as in other cases, speak louder than words.

Of course, now, and for a long time to come, the ignorant, the lowly organized, and the depraved will maltreat animals; and they must be appealed to in a way that is deterrent—that is, by punishment. But the sooner we can establish a strong and correct public feeling on the subject of the rights and relations of animals, the more effectually will cruelty be prevented; and when

it does occur, be detected and punished. All cases of prosecution should be published, on account not only of its preventive effect, but because it strengthens public sentiment.

The cause will be hindered by mawkish sentiment, interference to an undue degree in slight cases, while neglecting great and widespread injustice, or positive wrong, toward our faithful dumb friends. In spreading sound ideas in regard to animals; in correcting generally admitted and great cruelties; in providing temporary homes for lost and stray animals; by encouraging, directly or indirectly, scientific research in biology, especially on the diseases common to man and our domestic animals; in contributing to the investigation of animal intelligence—we have, in addition to many other lines of effort, large and worthy fields of endeavor for the improvement of the condition of things in the world in which we live, both for man and his fellow-creatures, lower in the scale, it is true, but withal very admirable.

THE OSWEGO STATE NORMAL SCHOOL.

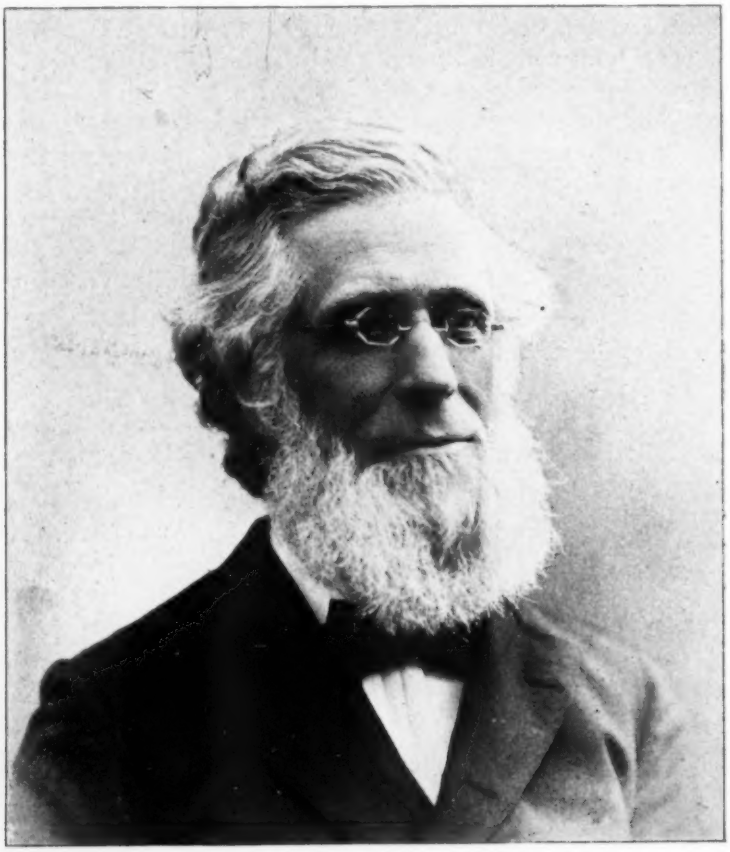
By Prof. WILLIAM M. ABER.

TO-DAY, in the quiet, old city of Oswego, N. Y., stands a school whose influence has extended throughout the land. At its head is its founder, Dr. E. A. Sheldon: the school is his life work.

In 1848 Mr. Sheldon, a young man of twenty-four, then a resident of Oswego, felt moved to study somewhat into the condition of the poor of that city. Their ignorance and misery excited profound pity. Influential friends were enlisted, an "Orphan and Free School Association" was formed, a schoolroom provided, and a teacher sought. To his surprise, he found that he must teach the school or the enterprise would be abandoned. For salary he asked the estimated cost of his living, two hundred and seventy-five dollars per year, and received three hundred dollars. In the basement of an old church, the inexperienced young teacher was brought face to face with one hundred and twenty wild boys and girls of from five to twenty-one. These he held in order and kept at work by insight, love, and patience—those potent exorcisers of evil spirits.

From this movement, though against strenuous opposition, sprang the free and graded schools of Oswego, which were organized by Mr. Sheldon in 1853. As a superintendent of schools he might have ended his days, had he not possessed qualities of mind and heart which led him to turn from easy, routine work and encounter toils and dangers to find or make a better way. As machines for securing from the pupils the learning, *memoriter*, of

so many pages per day, and from the teachers recitation-hearing, marking, and reporting, his schools were eminently successful. Teachers, pupils, and patrons neither knew nor desired anything better; but that sympathy with childhood which had led Mr. Sheldon into this work was not satisfied with these poor results. Five years of growing dissatisfaction with the current range of



E. A. SHELDON.

subjects and methods of instruction had culminated in a determination to prepare some books and charts for himself, when a visit to Toronto revealed the object of his search. He saw there in the National Museum, *though not used in their own schools*, collections of appliances employed abroad—notably in the Home and Colonial Training School in London. Evidently the seed sown by this school had not found in Toronto so good a soil as in the mind of this Yankee schoolmaster. From this visit he returned with the delight of a discoverer of a new world, laden with charts, books, balls, cards, pictures of animals, building blocks,

cocoons, cotton bolls, samples of grain, and specimens of pottery and glass.

In 1859 a new course for the primary schools was introduced at Oswego, in which lessons on form, color, size, weight, animals, plants, the human body, and moral instruction were prominent. But his teachers knew little about the subject matter of such lessons, and less about methods of teaching them. The superintendent was forced to become the teacher and trainer of his teachers. Without training himself, he sadly felt the inadequacy of his instructions, and determined to try to obtain a training teacher from

Old Normal School Building.

the Home and Colonial School. The Board of Education consented, "on condition of its not costing the city a single cent." To assist in providing the means, some of his teachers resigned, for one year, half their salaries, which ranged from three to five hundred dollars. Their names should be recorded among the founders of the school, and written in letters of gold on its walls. To begin this work, Miss M. E. M. Jones was obtained, for one year, from the Home and Colonial School. After school hours each day, Mr. Sheldon, his most interested teachers, and a few from abroad, sat for two hours in a small, obscure room to receive the instruction which had been brought from over the sea at so much personal sacrifice. For one year these men and women became as little children, that they might enter and win the kingdom of childhood through the door opened by Pestalozzi, for Miss Jones was a disciple of that master. The work thus begun was continued by some of her pupils, and by Prof. Hermann Krüsi, who also had taught in the Home and Colonial, and was a son of one of Pestalozzi's most trusted helpers.

For two years, this training class was maintained by the city.

In 1863 it was adopted by the State, and a grant of three thousand dollars per year was made for its support, on condition of the city's furnishing the necessary buildings and accommodations, and of not less than fifty teachers designing to teach in the common schools of the State receiving free tuition each year. These persons were to be recommended by county commissioners or city superintendents and appointed by the State Superintendent. In 1865 a building was purchased and fitted up by the Oswego Board of Education at a cost of twenty-six thousand dollars. In 1866 a general act was passed by the Legislature, which provided for four additional normal and training schools in various parts of the State, to be governed by local boards, appointed and removable at will by the State Superintendent, and supported by an annual grant of twelve thousand dollars each. On March 27, 1867, the building provided by Oswego was accepted by the State. With the appointment of a local board of thirteen, the Training School's connection with the city schools ended, except that which necessarily arose from the Practice School. So the city teachers' class had in six years grown into a State Normal and Training School, and had produced four other schools fashioned in its own image.*

The development from a training class for the primary teachers of one city to a school for the training of teachers for all grades and for all parts of the State, necessitated an enlargement of the curriculum. The one-year course was enlarged to courses of two, three, and four years. The first covered the field of instruction below the high schools; the second included high-school work; and the third added Latin and Greek, with German and French as an alternative for Greek. The last year of each course was devoted to professional work. In these enlargements there was no departure from the original plan. Instruction in the subject matter to be taught, in the history and philosophy of education, in psychology, in general methods of teaching, and methods in detail for special subjects, and practice in teaching have from the first characterized the Oswego school—characteristics which have been reproduced in most of the normal schools of the country. These enlargements were bitterly opposed by the private school interests of the State, represented in the academies; but they were forced upon the normal schools by two facts: most of the appointees were too imperfectly instructed in the subjects to enter at once upon the discussion of methods of teaching them; and if the schools had rejected all such appointees, their duty of furnishing teachers for the public schools of the State would have

* The Normal School at Albany already existed, but had been organized on a different plan.

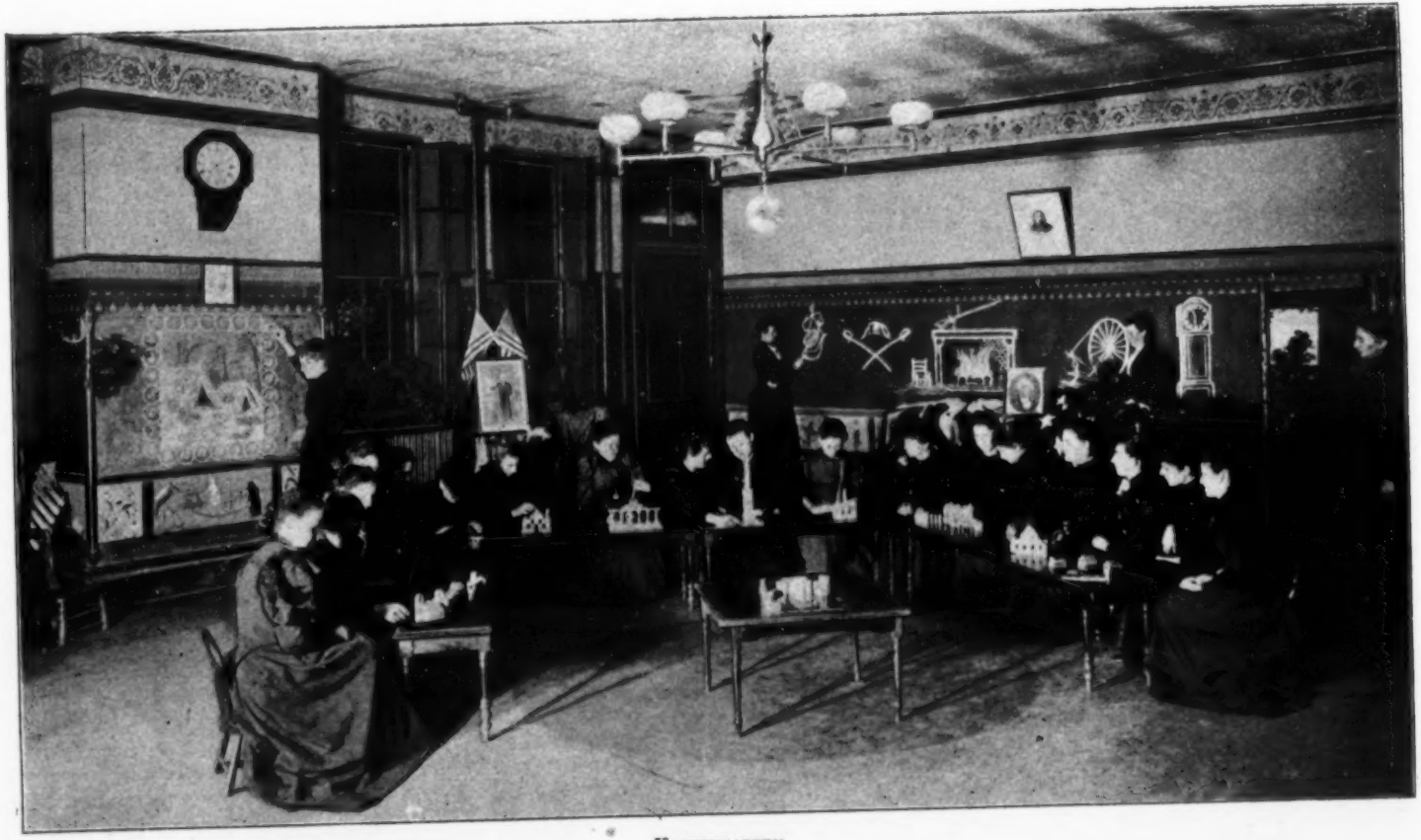
OSWEGO STATE NORMAL SCHOOL.

been so unfulfilled as to have imperiled their very existence. New York State makes her normal-school diplomas valid as life certificates, pays one half the railway fares of State appointees, and furnishes text-books free to all. Pupils from other States were formerly admitted free, but now pay a tuition of forty dollars per year. In 1892 the two years' course was dropped, and at present the State Normal Schools have three courses—an English course of three years, and classical and scientific courses of four years.

In 1890 the Oswego school decided to discontinue instruction in the ancient and modern languages "when the pupils already entered for these subjects shall have finished their courses"; but diplomas for the classical and scientific courses will be given to students who possess the required knowledge. This departure was made because Dr. Sheldon became convinced that more could be accomplished for the public schools by concentrating the energy, time, and money required for these linguistic studies on advanced academic and professional work on the lines of the English course. In lieu of these languages, the Oswego school now offers three one-year post-graduate courses:—advanced instruction in natural science, psychology, history, and English, and practice teaching in higher English and science subjects; kindergarten training, and special training for primary teaching; and preparation of teachers for teaching in training schools. For the kindergarten work a diploma is given: for each of the other courses a certificate testifying to the extra work and qualifications.

To keep pace with these various changes, the faculty of the school has been increased from six to fifteen persons; the annual appropriation raised from $3,000 to $21,000; and in 1879 a new building was provided by the State at a cost of $56,000. This building (see cut) stands on the summit of a ridge rising westward from the Oswego River. It forms three sides of an oblong, with a south front one hundred and ninety feet, an east front one hundred and thirty-five feet, and a west front one hundred and twenty-two feet. In its construction, exterior form and ornament were sacrificed for interior convenience and furnishing. It gives more recitation room and laboratory space, and is better equipped with appliances for the best methods of study and professional training, than some normal-school buildings of twice its cost. Arrangements for heat, light, and ventilation are excellent. On the first floor are the general offices and waiting rooms, the kindergarten and practice school; on the second, the assembly hall, library, reading room, and general recitation rooms; on the third, literary society rooms, scientific laboratories, and lecture room; and on the fourth, an art room.

The kindergarten is domiciled in the east end of the front, in a charming room, whose adornments and work make a fairyland



KINDERGARTEN.

PHYSICAL LABORATORY.

through which the little ones enter school life with fearless, happy steps. As the visitor watches the little ones at play, weaving bright colors, building with blocks, or molding clay into forms surpassing in interest even the mud pies of his childhood, he may sigh for his own first day at school. The writer's is an indelible memory. In a rough stone house, with a forest in the rear and a swamp in front—land of more value could not be afforded—he sat for hours, with dangling feet, on a backless slab bench, until called up to receive at the master's knees, from a tattered primer, his first lesson,—looking at and calling the names of queer marks whose appearance was not interesting, and whose use was not known. Fortunate children, for whose kindly and wise guidance over the threshold of education men and women of great minds and hearts have labored, will you, as actors on the stage of life, be wiser and better than this generation ?

The practice school has three large assembly rooms and twenty recitation rooms. The assembly rooms have lofty ceilings and great windows which preach the gospel of good air and sunshine, choice products of the children's work adorn their walls, and libraries for the children's use are attractive features. The school comprises from four to five hundred children of the primary, junior, and senior grades. Each grade is divided into classes of fifteen to twenty pupils. Each class is assigned its own room and a teacher from the normal class which has reached the point of practice teaching—the last twenty weeks of the courses. Each of the rooms is an independent school, for whose discipline and instruction the practicing teacher is primarily responsible. One of these teachers has for ten weeks a primary class and for ten weeks a junior or senior class; and the conditions are much like those which a teacher will have in a school of his own. The work of the same grades in the other schools of the city is done; and, in addition, extra work in drawing, color, form, work in modeling, parquetry, folding, cutting, sewing, and shop work with carpenter's tools. Drawing and modeling are extensively applied in the study of geography, plants, and animals. Each class room is adorned with the best work of its children; and ample blackboards give space for work in number, language, drawing, etc. In each is a cabinet to whose shelves field, forest, and factory have furnished treasures which delight and instruct the children. As these cabinets are constantly growing by the contributions of pupils and teachers, they have a future of great possibilities. They are all descendants of that little cabinet stored with the spoils of the Toronto visit.

The whole collection of little schools is under the charge of five permanent critic teachers upon whom the tone and character of the whole depend, and who have the ultimate responsibility for

the welfare and progress of the children. To attempt to give, in this article, details as to the methods of securing real practice teaching, and yet conserve the interests of the children, is not practicable. That these objects are attained is evidenced by two facts,—the practice school is popular with the city patrons, and the term of practice work is generally regarded by Oswego graduates as the most valuable in their entire course. It is justly so regarded; for five months of teaching under searching but kindly and constructive criticism may be worth more than years of unaided experience. The critic teachers, while employees of the city Board of Education and responsible to them for the discipline and progress of the city pupils, are chosen and nominated by the State Normal School authorities, and are responsible to them for the normal practice teachers. This arrangement gives opportunity for difficulty and friction; but there has been little serious trouble at Oswego, a fact which speaks volumes for the good sense and tact of all concerned. The executive ability and teaching power required to drill a succession of inexperienced teachers, and during this process to work through these teachers the same or better discipline and teaching than prevails in the other city schools, can be better imagined than described. Whether the saying, "A teacher is born and not made," is true in all branches of the profession or not, it certainly is true of the critic teachers of a great practice school.

On the second floor of the building are eight recitation rooms, seating from fifty to one hundred students, devoted to mathematics, language, history, etc., and supplied with maps, charts, models, ample blackboards, and abundant light. The reading room and library on this floor have the standard periodicals and well-selected books. The visitor can not forbear the wish that some of the thousands yearly wasted by New York State could be used to increase this library; yet smallness is not an unmixed ill for a school library if the books are the best of their kind, and the limited number secures concentration of attention and thorough acquaintance. The Oswego School Library is supplemented by the City Library, whose volumes are accessible to the normal students.

The Normal Assembly Hall occupies the entire upper portion of the west wing. This wing, although of the same height as the main part of the building, is divided into but two stories above the gymnasium, thus securing extra height of ceiling for the assembly rooms of the practice school below and for the Normal Hall above. This hall is sixty-eight by seventy-six feet, seated for four hundred students, and has a capacity for three hundred additional seats on public occasions; it has large windows on three sides, and plain but tasteful coloring and decoration.

The third floor is the domain of the natural-science department

Zoölogical Laboratory.

Botanical Laboratory.

whose laboratories and lecture rooms occupy almost the whole space. The zoölogical laboratory is at the western end of the front, the mineralogical and geological at the eastern, and between them are the physical laboratory, storerooms, and lecture rooms for these sciences. The botanical and chemical laboratories are in the east wing. The zoölogical laboratory—extending thirty-two by fifty-six feet, flooded with light by a row of southern windows, lined on its northern side by spacious glass-fronted cases of specimens, at its eastern end a large tank for the storage of working materials, on the floor tables, and along the southern side a broad shelf, sufficient in all to furnish room for a hundred workers—wins the heart of the zoölogist. It has a full supply of dissecting apparatus and small microscopes for elementary work, and a fair equipment of large microscopes with accessories for more advanced work. The botanical laboratory is twenty-eight by forty feet. The other laboratories furnish working facilities for forty pupils each. The furnishing of the chemical laboratory is noteworthy for the convenience of the tables, apparatus, and water supply. In the largeness and fineness of the home provided for the natural sciences in this building, as compared with the crowding of these subjects into two or three small rooms in some recently erected normal-school buildings, there is a fit expression of Oswego educational ideas.

The art room on the fourth floor is forty-four by fifty-two feet, admirably lighted, and furnished with fine facilities for teaching drawing. Two of the three literary societies of the school—the Athenean and Adelphi—have private rooms neatly fitted up and furnished by themselves. The rhetorical and literary work of the school is largely done in connection with these societies. The Adelphi and Athenean lay out their own work and conduct their business in their own way. Alternately, about once in two weeks, they give public exercises in the Normal Hall. The Keystone, which embraces the lower classes, is in charge of members of the faculty and occasionally gives a public exercise.

On the ground floor is the workshop, provided with engine, lathes, circular saws, tools, benches, and facilities for various kinds of woodwork. In this the normal students learn to make the simpler pieces of scientific and other apparatus, and get some skill in using tools. In the class in familiar science each pupil constructs his own apparatus for illustrations and thus becomes provided with the necessary apparatus for teaching the elements of science in public schools. A room for clay modeling and one for free-hand drawing is also supplied for the manual training work. The Normal School Gymnasium is on the ground floor of the west wing. Daily exercise is required of all students, and is considered important, both for its immediate effects upon health and

comeliness, and for instruction in methods of physical training. The gymnasium is large and well equipped, and was until recently under the charge of Dr. Mary V. Lee, a physician who was a specialist in physical training and made much use of the Delsarte system. Her recent, untimely death has left the department in charge of one of her pupils.

From the observatory, which crowns the central front of the building, the students see, as a whole, the views which all day long they catch from the windows below—views which have no small part in their student life. Northward stretches Ontario with boundless limit, its shores extending right and left in winding curves, bold bluffs, lowland, field, and forest. Below and around is the city: to the east, sloping down to the river and rising beyond it; to the west, soon shading off into farm lands; to the south, rising in a steep slope on which stands the City Orphan Asylum, a sister institution, tracing its origin to the same source. Whether the water and land sleep under a June sky or are vexed by January storms, the eye need ask for no finer scene.

As the mother of normal schools and methods, the Oswego school presents its most interesting aspect. Normal schools have been organized on the Oswego plan and called Oswego graduates to introduce her methods—as city schools in Portland, Boston, New Haven, New York, Philadelphia, Cincinnati, Indianapolis, Detroit, Washington, D. C., and other cities of less note; and as State schools in all the New England States, in New York, New Jersey, Pennsylvania, Indiana, Illinois, Wisconsin, Iowa, Minnesota, Nebraska, Kansas, Missouri, Mississippi, and California.* This influence was felt first in New England and the Mississippi Valley and later in the South.

The graduates of the Oswego school number 1,703. Oswego graduates have taught in every State and Territory except Idaho and Nevada, in the District of Columbia, and in five foreign countries. Of the graduates who were born and reared in New York State over four hundred have been called away to teach in thirty-nine States, two Territories, the District of Columbia, Canada, Mexico, South America, Sandwich Islands, and Japan. New York State has complained that through Oswego she has educated teachers for the schools of other States; but could any but an unnatural mother fail to be proud to have her children worthy to be thus called away, and glad to have within her borders an institution whose graduates are sought for from the Atlantic to the Pacific, from Canada to the Argentine Republic, and the borders of Asia?

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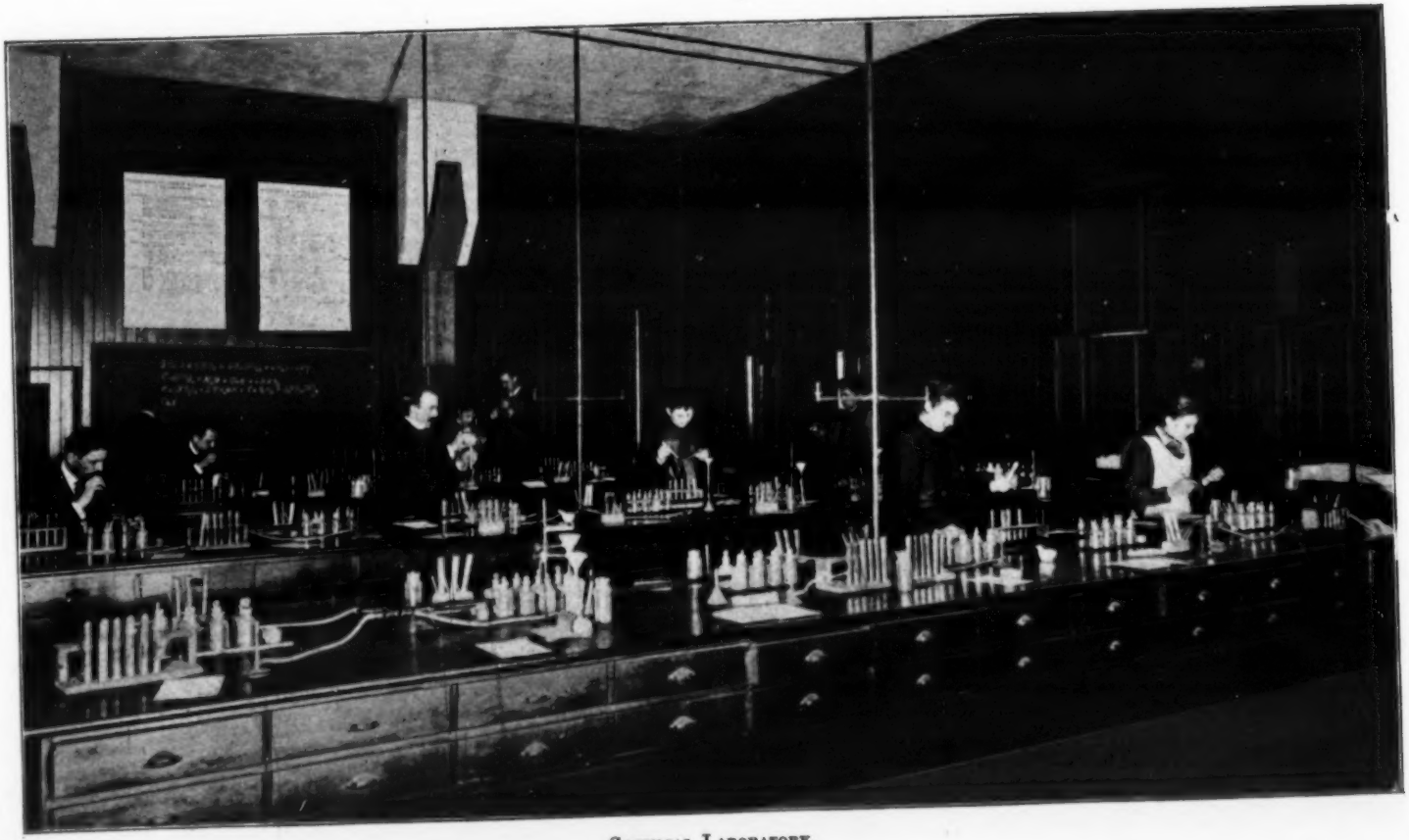
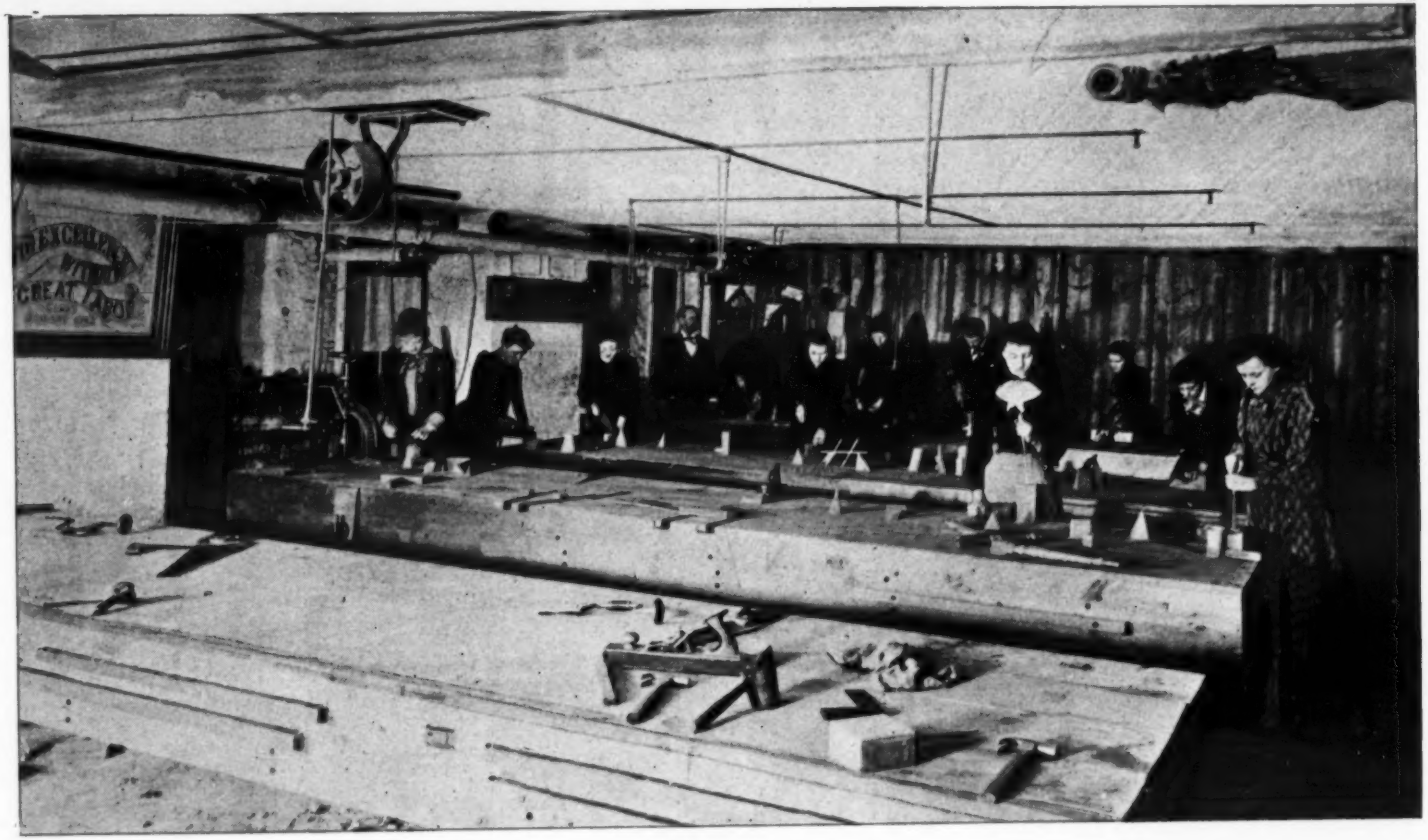
* See Circular of Information No. 8, 1891, Bureau of Education, Washington, D. C., and Historical Sketches of the State Normal and Training School at Oswego, N. Y.



CHEMICAL LABORATORY.

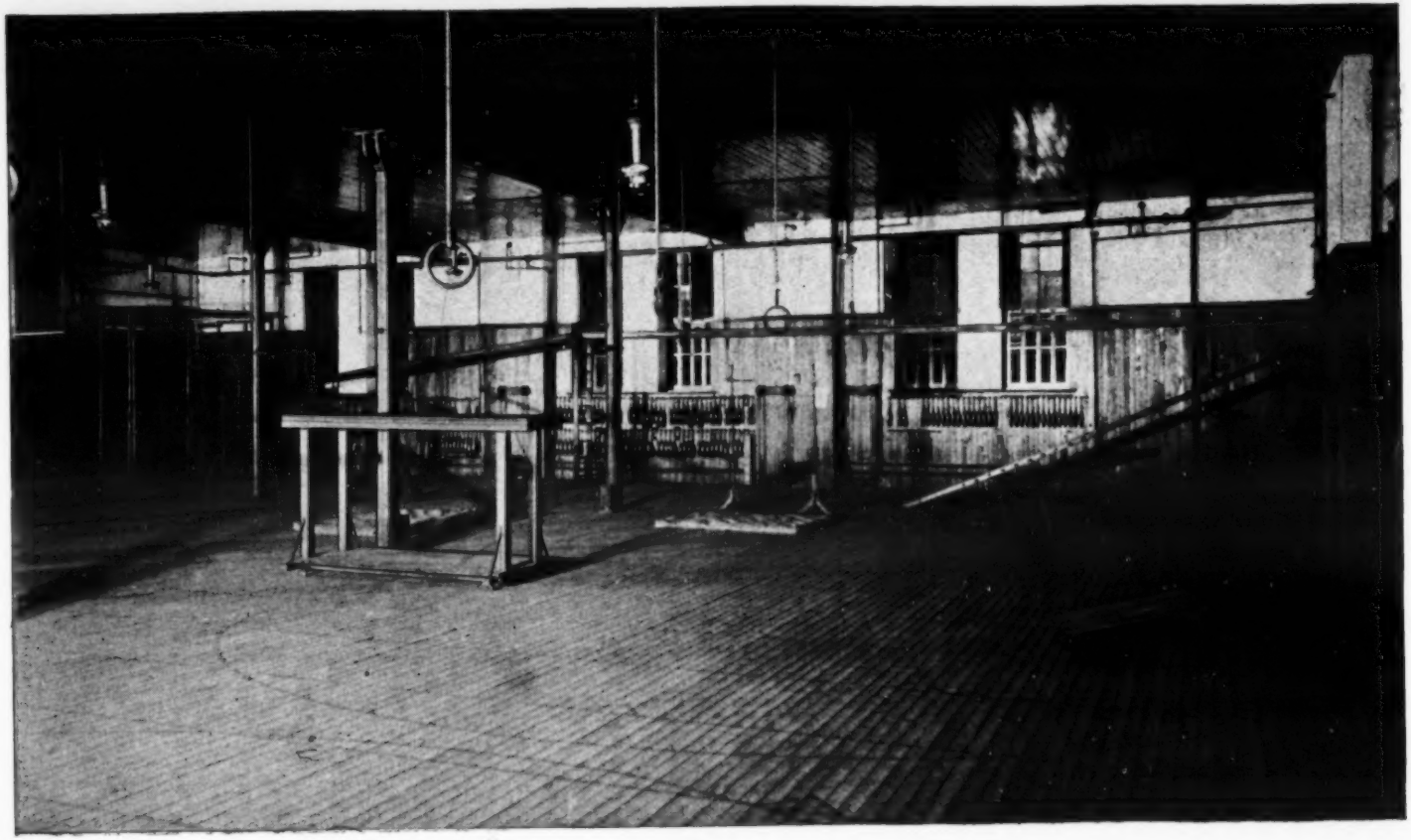


WORKSHOP.

The fundamental causes of this widespread influence were the educational unrest which filled the United States forty years ago, and the fact that through Mr. Sheldon's efforts the Oswego school offered a means of satisfying it. This unrest made a good soil for the new educational ideas; these new ideas were discussed by school men before New York State had a normal school; and the school at Albany was founded and began the teaching of educational theories before the Oswego school was even thought of. What Mr. Sheldon did was to focus all these floating ideas on actual practice, and work out a systematic and rational expression of these theories for the daily work of the schoolroom—to do what other men were dreaming about. Doubtless Mr. Sheldon had unusual genius for organizing and teaching, but these exercised under purely selfish motives would not have led to such results. School work as a business, pursued for salary alone, attains no more than it seeks. E. A. Sheldon with his ragged Oswego boys and girls in 1848, and Heinrich Pestalozzi with his destitute orphans at Stanz in 1799, teach the same lesson. Love, hope, and faith are the most potent forces in education as well as in religion. Through these forces the Oswego movement began; through these, its founder became and has remained a seeker for educational righteousness, ready to try all things and to hold fast the better; through these, he became receptive of good influences from all sources, and eagerly sought to impart them to others. An incident occurring in 1861 shows how Oswego's gospel was at first spread. An invitation was issued to leading educators of different States to come to Oswego to observe the methods. This invitation was cordially accepted, and after careful examination these observers made a favorable report, stating that "the system of object teaching is admirably adapted to cultivate the perceptive faculty of the child, to furnish him with clear conceptions and the power of expression, and thus to prepare him for the prosecution of the sciences or the pursuits of active life." They also expressed the opinion that this system "demands of the teacher varied knowledge and thorough culture; and that attempts to introduce it by those who do not clearly comprehend its principles, and who are not trained in its methods, can result only in failure," thus indorsing the necessity of training schools.

The system introduced at Oswego is commonly called Pestalozzian, because it was inspired so directly from that source, for the Home and Colonial was founded by disciples of Pestalozzi. The essentials of Pestalozzianism may be summed up as a new point of view; and, as resultants of this, a new conception of education, and methods appropriate for realizing it.* The old education takes

* See Krüsi's Life and Work of Pestalozzi.



GYMNASIUM.

the standpoint of the adult; the new, that of the child. From the former, the whole mass of heterogeneous facts composing the knowledge to be acquired is viewed as having been classified, labeled, and stored in books. From this conception, what method of acquiring knowledge can be more direct than the memorizing of books? By a cheerful optimism this system crams the child with words, and trusts that somehow he will grasp the ideas for himself and will have his powers cultivated in the process. In exceptional cases these objects are accomplished; but the average child is left in a condition of permanent mental dyspepsia and torpor. The new education conceives the child as looking forward into the phenomena of Nature and life, curious and eager to know realities first, then to express his knowledge, and delighted with the exercise of his powers. To bring the child into contact with facts, to guide him in classifying and labeling these facts for himself, becomes the teacher's first and chief duty, in obedience to the sound principle that development of powers is gained by their exercise only. From this point of view education is conceived of as a natural process extending from the cradle to the grave, with Nature as the chief teacher, and the mother as the first assistant, whose work is carried on by the schools and the experiences of life. In this natural process of education, ideas come before expressions, whether the idea be the child's first conception of color and form or the profoundest abstraction of a philosopher; and its principles are therefore applicable to education in all grades from the kindergarten to the university.*

As to the correctness of this conception of education and the general means of realizing it, there is substantial unanimity among school men; but, as to details of courses of study and methods of presenting subjects, diversity of opinion necessarily exists. Here, as in other fields, practice lags far behind theory. To the Oswego school belongs the honor of having developed in great detail courses of study and methods of teaching that have received the indorsement of educational reformers and of teachers in hundreds of schoolrooms as being capable of realizing in large measure the true educational ideal. Here also were devised simple and efficient means for giving teachers the training required for the new kind of work. To all who know how broad and how difficult to bridge is the chasm between educational theory and practice, these achievements will seem of no small importance. In this connection, Prof. Hermann Krüsi, for twenty-five years the teacher of the history and philosophy of education, geometry, French, and German; Miss Matilda S. Cooper, for the same period teacher

* For an interesting application, see Sheldon's General History, and Sheldon-Barnes's United States History, by Oswego graduates.

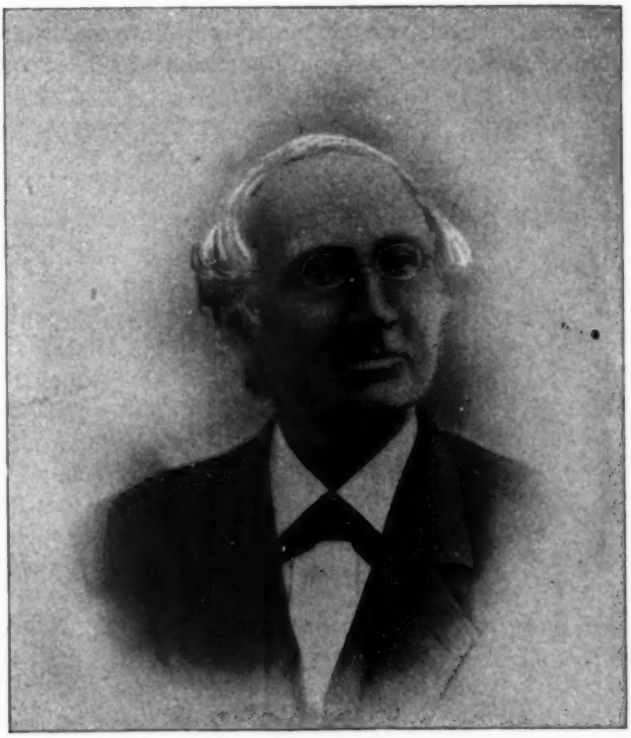
of English grammar and primary methods; and Prof. Isaac B. Poucher, from 1867 to the present time—excepting an absence of four years—teacher of arithmetic, algebra, and methods of teaching these subjects, should be especially remembered. In many a school called normal the pupils are, in preparatory instruction, taught exactly as they should not be, in defiance of the principles and methods to be mastered in their professional training. At Oswego the preparatory work in mathematics, language, history, natural science, etc., has, for the most part, been done by intelligent and loyal adherents of the school's professed principles, and been consistent with the methods inculcated in the professional work. The students having seen the daily application of these principles and methods to all sorts of subjects, and experienced their value in their own persons, more easily comprehend and apply them in subsequent method and practice work.

The Oswego movement did not lack opponents—a class whose services in all reforms are equally useful as extinguishers of false lights and disseminators of true. The most notable of these helpers was Dr. Wilbur, Superintendent of the New York State Idiot Asylum, a man eminently successful in his work. In the New York State Teachers' Convention of 1862, and in the National Convention of 1864, he severely attacked the whole system, from philosophical standpoints. In consequence, a committee was appointed to examine thoroughly the practical bearings of the "vicious" system. The chairman of this committee, Prof. Greene, of Brown University, visited the Oswego schools, tested their results thoroughly, and made his report before the National Convention of 1865. This report was so intelligent, exhaustive, and favorable that the underlying principles of the Oswego methods have never since met serious opposition in any authoritative body.*

Students at Oswego have sometimes complained of the rigorous drill of classes in methods, and of the practice school, as too mechanical, tending to produce mannerisms and to crush individuality. These complaints were sometimes made by those who best comprehended the principles and felt the power and desire to work out their own applications. These complaints admit this answer: For the average man and woman comprehension of principles does not secure practice. The principles must be embodied in precepts and rules, must be applied in a practical course of action under whose influence habits of right conduct are formed. Right habits can not be formed in the teacher by imparting to him the principles merely of his profession more than in the soldier. If in some cases the product of drill is a mere machine, it is

* See Circular of Information, No. 8, 1891, Bureau of Education, Washington, D. C.

usually because the person is inclined to become a machine, and a well-constructed machine is better than a poor one. The few so specially gifted as not to need so much detail and drill suffer no permanent injury by the temporary restraint of their powers of independent action. The habits formed in the thorough training school will but aid their steps into new paths in the wide field beyond its walls. To the careful, unremitting drill of her method and practice school work is largely due the fact that the Oswego Normal School has turned out so large a product of successful



HERMANN KRÜSI.

teachers as compared with her production of mere talkers and essay writers. No one else deserves so much credit for this as Miss Cooper. The maxims, The idea before the word, The concrete before the abstract, One step at a time, Never tell a child what he can find out for himself, were constantly applied by her as the plumb-line and try-square to test all work. Her method of inculcating principles and teaching the art of questioning was philosophical. The student was required to write out a series of logical questions and answers for drawing out the ideas to be taught; not once, but daily for twenty weeks, in a series of graduated lessons in each of the subjects to be taught in primary

schools. The imaginary child which each student set up for him self displayed his ignorance of child life; and his processes of questioning showed the limitations of his grasp of the principles involved. To the student whose sympathy with childhood is spontaneous and whose grasp of principles is intuitive, such drill is needlessly irksome. But that the vague notions of childhood and vaguer grasp of principles of most normal students can be developed and trained by such courses of drill only, the subsequent twenty weeks in the practice school will abundantly demonstrate.

The school has been exceptionally fortunate in its social and physical environments; and no enumeration of the causes of her

MATILDA S. COOPER.

success can afford to omit these potent influences. The site of the city, at the mouth of the Oswego River and on the shores of Ontario, one of the fairest of our Great Lakes, is unsurpassed, both for beauty and for commercial and manufacturing advantages. Ridges which rise gently on both sides of the river near its mouth, and, farther back, form bold, picturesque hills, furnish almost ideal ground for a city. The place is not lacking in the charm of his-

toric associations. As one of the gateways to central New York, its old fort was the prize of battle between Indian, French, English, and Continentals during colonial and Revolutionary days. To one who has stood on the bluffs to the west of the old harbor, with the lake outspread as a shining mirror, and listened to the soft lapping of the waters on the shelving rocks below; or from the crumbling ramparts of the old fort on the eastern side has watched the sun like a burnished, golden shield slowly sink into the western waters, sending a flaming track across the wavelets, the soothing and restful influences were of unspeakable value. For a time the fret and fever of ignoble strife departed, and in the saner hour the spirit was open to better impulses. When the waters were lashed into fury by storms and hurled in fierce onset against the rocky shores, not less useful inspiration came from wind and wave—exultation in strength and courage for conflict. Nor did these influences altogether perish with the hour. What Oswego pupil, susceptible at all to Nature's influence, did not feel the power of those scenes and does not cherish their memory?

The social and religious influences of Oswego have been favorable to the Normal pupils. The city is not so large as to cause the Normal School factor to be ignored, nor so small as to cause it to have undue prominence. In churches, Sunday schools, and other societies pupils have been welcomed as guests and kept as valued helpers. A more important social influence has been the free mingling in work and recreations of the young men and women composing the school. In the recitation rooms and laboratories, this influence has produced wholesome rivalry and respect for one another's powers; at social gatherings and merrymakings, it has been refining and ennobling. For many a bashful boy and shy maiden, excursions on the lake and rambles in woods and fields have replaced awkwardness and constraint by the easy, natural manners of comradeship, and given insight into each other's natures and characters. Such introductions into the kingdoms of true manhood and womanhood are not the least among the school's gifts to her children. Social intercourse has always been left as free as the ordinary rules of propriety admit. Rarely has this freedom been misused, and the good arising from it has outweighed a thousandfold the evil. An important center of the school's social life is the Welland, the girl's boarding hall, whose parlors have so often echoed to the pleasures of the Friday evening socials.

Dr. Sheldon's home has been the chief center and source of social influences. This home is situated on a high, wooded point of the lake shore, a mile west of the city—a very paradise for quiet beauty. On the spacious grounds, beneath the shadow of

great forest trees, and in the hospitable halls of this home, many a generation of Normal pupils have had their merrymakings—springtime maple-sugar parties and autumnal fruit festivals and corn-roasts—the hearty participation of the master and mistress of the place making all feel at home. This home—with its evidence that refinement and simple but generous hospitality can be

ISAAC B. POUCHER.

maintained without wealth or extravagance; that gentle, winning manners and a cheerful heart are not incompatible with serious character and heavy burdens—has been the finest object lesson at Oswego.

Thirty years have passed since the tender shoot was planted that has grown into this stately tree: its fruits have dropped all over our land; some of the seeds have fallen on stony ground and withered away after a superficial growth; others have been choked by the growth of purely selfish ambitions and brought forth little fruit; but some have fallen on good soil and brought forth an hundredfold. Much has been done for education in our land during these thirty years, but a thousandfold more remains to be done to make the public schools what they must become to merit confi-

dence as the efficient conservators of our national happiness and prosperity. In the work of the past, the Oswego Normal has played an honorable part; but her mission is not yet ended, nor her powers abated. With youthful energy, both at home and through her graduates,* she is grappling with the question of *what* to teach, a question of not less importance than the *how*. That more useful and interesting material for study may be brought into schoolrooms, especially in the primary, is to be ardently desired. The best methods applied to trite or useless subject matter can not make school life interesting or valuable to pupil or teacher.

After all that has been done, and well done, no one but a most willful optimist can be blind to the lamentable defects of our schools.† The censure for these defects usually falls upon teachers, but does not primarily belong there. *Teaching* requires insight into and sympathy with child life, a condition spontaneous in but few adults, requiring in most laborious and sustained effort to gain and to maintain it; and a constant effort to advance in scholastic and professional attainments to escape slipping back into the abyss of slothful indifference. *Teaching* is, of all the professions, the most useful for the public welfare, as it is one of the most laborious and skilled, and should be paid according to its deserts. *Recitation-hearing*, however, is one of the easiest, least skilled, and most useless of all occupations. In this field, as in others, the public gets the kind of work it pays for. The wages of the rank and file of public-school teachers average less than those of skilled mechanics. As long as the public continues to pay for *recitation-hearing*, it will not get much *teaching;* for educational missionaries to work without the ordinary inducements are too few to supply the demand, and will probably continue so until the millennium.

There is need of educational statesmen to secure legislation efficient for preventing the employment of teachers without adequate scholastic acquirements and professional training, as physicians are forbidden to practice without such attainments. Is the body of so much more value than mind or soul that it should have greater safeguards? There is need of educational agitators to rouse and awaken the people from complacent day-dreaming about the schools, to show them that much of their expenditure is wasted through poor work, and to convince them

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* See work of Mr. L. H. Jones for Indianapolis schools in the Forum for December, 1892; "An Experiment in Education," in Popular Science Monthly for January and February, 1892; and the work of Prof. Barnes in Stanford University.

† See articles by Dr. J. M. Rice in the Forum for October, November, and December, 1892.

that better pay and more honor for their teachers would be a wise economy.

That our alma mater may bear as brave and glorious a part in the struggles of coming years as in the past must be the heartfelt wish of every graduate of the Oswego Normal and Training School.

DECAY IN THE APPLE BARREL.

By BYRON D. HALSTED, Sc. D.,
RUTGERS COLLEGE.

FRUITS decay and everybody knows it, but how this rotting takes place is less evident. Grandfathers told our parents that it was due to the weather, and some of them may have held to the notion that the moon had a remarkable influence upon the keeping quality of various fruits. The perfection of the microscope and its more general use as an aid in seeing the minute things which surround us upon every side have led to a deeper comprehension of decays. It is the purpose of this article to show, if possible, some of the facts connected with the rotting of our apples, realizing that what holds true concerning one kind of fruit applies almost equally well to others.

Let us in the first place take a survey of the normal subject, or, in other words, of a healthy apple. It is made up of five seed cavities which occupy the central portion of the fruit and constitute the core. Outside of this is the edible portion called the flesh, consisting of cells of small size filled with liquid substances. A tough layer covers the outside, which is the skin, and bears the coloring substance that determines whether the apple is green, red, mottled, or striped. At one end of the fruit is the stem, or, as found in the barrel, this former means of attachment to the branch of the tree may have been broken away or pulled from the fruit—a matter of no small consideration when the question of decay is concerned. This end of the apple is known to the horticulturists as the "cavity," and varies greatly in different sorts, sometimes being deep and narrow as in the Winesap and Pearmain, and broad and shallow in the Greening and Peck's Pleasant.

The opposite end of the apple bears the name of "basin," and contains the remnants of the blossom—sometimes called the eye of the fruit. This part of the apple is likewise deep in some varieties, and shallow and open in others. This is the weakest point in the whole apple as concerns the question of the keeping quality of the fruit. If the basin is shallow and the canal to the core firmly closed, there is much less likelihood of the fruit decay-

ing than when it is deep, and the evident opening connects the center of the fruit with the surface.

For its own protection the perfect apple has a continuous layer of skin over its whole surface. The stem has not been removed from its cavity, but remains of its full length, for there is a place naturally provided for its separation from the branch which bore it. Such an apple is the rare exception as found in the barrel. At the market or in the storeroom of the consumer, instead of being without blemish upon the surface, there are small specks as large as a pin-head, or smaller, which dot the skin in patches. A portion of the surface of an apple with these specks is shown three times magnified in Fig. 1. Sometimes one needs to look for a long time to find a fruit entirely free from these specks. Under the compound microscope these dots are resolved into a thin layer of interwoven threads, with their free ends radiating from a central point. This is one of the low forms of plant life belonging to the molds, and grows from microscopic cells called spores, which in the economy of the mold serves the purpose of seeds. These spores are produced in great abundance, and, being carried by the air, alight upon the fruit and there germinate and grow into a colony or speck which is all the time feeding upon the substance obtained from the skin of the apple.

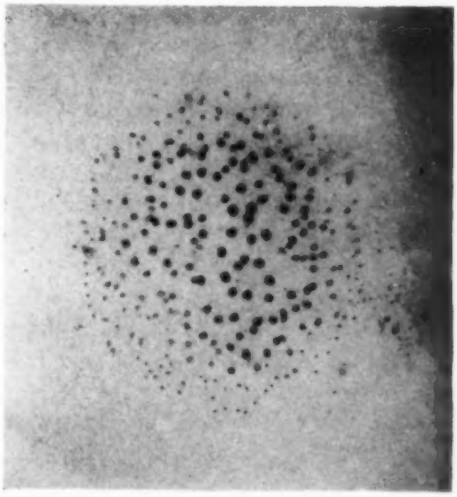

FIG. 1.—APPLE SPECKS. (Magnified.)

The second defect in apples, as seen in the barrel, is the one known to fruit-dealers as the "scab." To the eye this is recognized by the rough-coated patches, often circular in outline, that are present upon the skin. There may be several of these spots, and, by their borders becoming confluent, one half or less of a fruit may be thus rough coated and more or less dwarfed, making the apple one-sided. This scab is due to a mold which, under the microscope, is as different in its real structure from the specks above mentioned as the two are unlike in general appearance. If it will add anything to the value of this popular article, the botanical name of the species of mold causing the apple scab may be given as *Fusicladium dendriticum*, Fl. It is as much a distinct

kind of plant as the apple tree upon which it thrives. It is not confined to the fruit, but grows luxuriantly upon the foliage, causing it to become blotched with the brown patches and otherwise destroyed. The mold consists of fine, cobwebby threads, which penetrate the leaf and rob it of nourishment, and after a time form patches upon the surfaces, where innumerable spores of a dark color are produced.

The apples are first attacked by the scab fungus when they are quite small, probably while the tree is in blossom, or shortly after. At that time the surface of the young fruit is tender and has no well-developed skin, which, when the fruit nears maturity, might be so tough as to prevent the entrance of the scab mold. This, therefore, is a defect that does not come upon the fruit after harvest, and usually does not spread much after the apples are in the barrel.

The knowledge of the fact that the scab is due to a mold that begins to infest the fruit in early summer has led to experiments

FIG. 2.—APPLE SCAB.

in spraying the trees during the growing season with the Bordeaux mixture and other fungicides, with marked success in checking its ravages. Trees sprayed three or four times in May or June have borne abundant fruit comparatively free from scab, while unsprayed trees otherwise alike yielded a scant amount of distorted, scabby, withered apples. Fig. 2 shows an apple that is a fair illustration of the working of the scab fungus.

One of the most interesting things in connection with the study of the decays of apples is the relation which one mold bears to another. There are several very common kinds of molds,

which grow nearly everywhere when circumstances favor them. Their spores seem to be almost omnipresent, but they do not possess the ability to penetrate tough substances, and the natural skin of the apple is usually a barrier they can not pass. Of all these molds the *Penicillium glaucum*, Lk., or commonly known as the "blue mold," is the one that causes the greatest destruction in the storeroom. A large part of the rapid soft rot is due to the *Penicillium*.

In a few words let the work of the scab fungus be reviewed. As the name indicates, it causes a scab upon the surface, the

FIG. 3.—APPLE MOLD FOLLOWING APPLE SCAB.

naturally smooth, tough skin is roughened, and minute cracks are produced which in short replace the ordinary skin, impervious to the blue mold, with a disrupted coat that furnishes both a fine lodgment for the spores of the mold and the condition favorable for their germination and the further rapid growth of the mold. It is easy to conceive of the scab upon an apple being so slight and superficial as not to affect its real value, but the one defacement becomes the entrance of a decay germ, that in a few days reduces the whole apple to a noisome mass of rottenness resulting in a million spores or blue mold. To prevent the soft rot of the apple in midwinter in the barrel, the trees need to be sprayed in midsummer in the orchard, to check the development of the scab that would otherwise furnish the place of entrance of the blue mold. Fig. 3 shows an apple that, when harvested, had a number of rough circular patches due to the scab fungus. When the photograph was taken, each one of these spots was the seat of a

rapid decay, due to the development upon them of the *Penicillium*, while all other portions of the fruit were in a normal condition.

There are many diseases due to those exceedingly minute germs so widely talked of nowadays—namely, the bacteria. They attack animals and induce fevers of many sorts, and man sinks before them with the dreaded cholera, consumption, etc. Plants have their enemies among these micro-organisms, and apples do not enjoy an immunity from them. The succulent substance of a ripe apple is a favorite food for the bacteria, the only check upon their abundant entrance being the tough skin. But there are too many weak places, and it is presumable that these germs when falling upon them are capable of beginning their course of rapid multiplication which, when unchecked, reduces the fruit to rottenness. In Fig. 4 is seen an apple under the apparently unbroken skin of which in several places were decaying spots with no signs of any other mischief-makers than the swarming mil-

FIG. 4.—APPLE BLOTCH.

lions of the micro-organisms. As soon as the skin becomes broken in any such places, the coarser decay germs enter and quickly the fruit is overrun with a motley vegetation of various molds.

If we look further among the decaying fruits, it will not be long usually before an apple is found that does not agree with any of the descriptions given above. Perhaps it is healthy in all parts save one, and that has no scab present. The blue mold is

absent, the skin is unbroken except in a peculiar, almost regular manner. There is an evident central point where the fungus started, and, as it has spread, numerous pimples have formed just under the skin, and sometimes in eccentric circles. From these minute light-colored pimples spores ooze out and are ready to find their way to some other specimen. The affected portion of the apple has a bitter taste, and, on account of this, the term "bitter rot" has long been given to this form of decay. This

FIG. 5.—APPLE BITTER ROT.

same fungus causes the rotting of the grapes, and, if all the facts were known, this *Glœosporium fructigenum*, Berk., might be definitely charged with a large percentage of the decay of other fruits. An apple badly affected with the bitter rot is shown in Fig. 5, but one regrets that many of the details are lost in the photo-engraving process by which the engraving was made.

This form of rot while it may be met with upon the tree or in the windfalls beneath it in late summer, is most abundant in the storeroom and is decidedly contagious—that is, an apple that is decaying with the bitter rot is able to communicate the decay to other fruits by means of the myriads of spores which are borne upon the surface of the ruptured pimples. These facts suggest the precaution of discarding any rotting fruits whenever found. There is little room for doubt that were the harvested fruits themselves sprayed with a fungicide, it would aid materially in preserving them. Thus, if a thin coating of the Bordeaux mixture was applied, the spores of bitter rot and other decay germs would not so readily germinate. But there is the

objection of having the beauty of clean fruit lost under a film of fungicide that while not particularly poisonous is decidedly unpalatable, consisting of lime and sulphate of copper. A sensation was created in New York two years ago because grapes were thus marketed, and the same process for stored fruit is not here recommended, although its effectiveness as a preservative is granted.

A decay that might be mistaken for the last mentioned is caused by a fungus of a widely separated order. It is shown in Fig. 6. This might be called the black rot, as it has a strong tendency to turn the affected portions of a dark color. One of the characteristic features is the almost black pimples formed in considerable numbers beneath the skin, which they finally rupture and then discharge large numbers of dark-olive spores. This fun-

FIG. 6.—APPLE BLACK ROT.

gus is a described species bearing the name *Sphæropsis malorum*, Pk. It may be seen in early apples before they begin to ripen, and the windfalls as they lie upon the ground become badly infested with the *Sphæropsis*. It is not confined to the apple, but thrives destructively upon quinces and pears as well. This decay in its habits of growth calls to mind the fact that the basin is the weakest point of fruits like the three above mentioned, for in most instances the black rot begins at the free end where the remnants of the flower may be still adhering, and very likely assist in the fungus gaining a foothold. This decay, like the bitter rot, is amenable to treatment, and therefore, in order to check their destructive work in the storeroom, the fungicide needs to

be applied while the fruits are growing upon the trees. Thus the work of the prevention begins a long time previous to picking—while the barrel-staves are possibly still in the living forest tree. This reminds one of the time when the boy's education should begin as stated by Dr. Holmes, namely, with his grandfather when he was a small lad.

Up to this point remarks concerning the mechanical treatment of apples have been purposely withheld. There is no question about the importance of so far as possible preventing the bruising of the fruit. From what has been said in strong terms concerning the barrier of a tough skin which Nature has placed upon the apples, it goes without saying that this defense should not be ruthlessly broken down. It may be safely assumed that germs of decay are lurking almost everywhere, ready to come in contact with any substances. A bruise or cut in the skin is therefore even worse than a rough place caused by a scab fungus as a lodgment provided by the minute spores of various sorts. If the juice exudes, it at once furnishes the choicest of conditions for molds to grow. An apple bruised is a fruit for the decay of which germs are specially invited, and when such a specimen is placed in the midst of other fruit it soon becomes a point of infection for its neighbors on all sides. Seldom is a fully rotten apple found in a bin without several others near by it being more or less affected. A rotten apple is not its brother's keeper.

The surrounding conditions favor or retard the growth of the decay fungi. If the temperature is near freezing they are comparatively inactive, but when the room is warm and moist the fruit can not be expected to keep well. Cold storage naturally checks the decay. The ideal apple has no fungous defacements and no bruises. If it could be placed in a dry, cool room free from fungous germs it ought to keep indefinitely until chemical change ruins it as an article of food. But the facts in the case are far different from this ideal. The apple when gathered from the tree may have the germs of decay already within its tissue. They may have extended through the basin, become firmly located in the ragged remnants of the flower or by means of some insect or "worm" that has bit or burrowed the fruit. Its stem may have been broken close to the fruit or pulled out from it, or over the surface specks and scabs may have formed during the season of growth that have so destroyed the skin as to furnish a ready entrance for other more destructive germs. Bruises of the pulp and breaks in the skin expose the soft, highly decomposable flesh to the "seeds" of decay, and as one contemplates what an apple is made of and its many enemies, it seems almost a marvel that fruit keeps at all until it is cooked to kill the germs within it and then canned to prevent the entrance of those that are without. It

is not designed that apples in their natural state should keep for long, and all attempts to preserve them in the fresh condition through the winter and far into the succeeding spring are a triumph against Nature only to be won by the person who is conversant with the methods of his microscopic opponents. The use of fungicides in the orchard while the fruit is growing will insure more and fairer specimens, thus filling a larger number of barrels with apples that are less subject to attack after harvest. This, with careful handling to avoid bruises when picked and housed, together with a dry storage room, should all bring a full reward. Fig. 7 shows an apple in the last stages of dissolution, overrun inside and out with a diminutive forest of fungi. It is the seed-

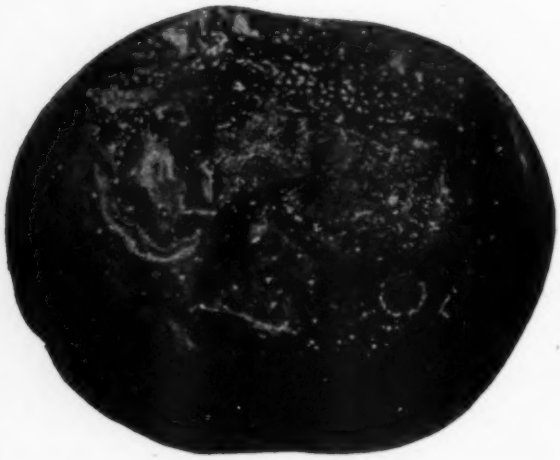

FIG. 7.—APPLE MOLD.

time, so to speak, with the host of species each vying with the others for the last particle of the apple, the seeds only being left behind ready to grow into trees when suitable circumstances obtain, provided the vital spark does not expire before the favoring condition arrive. The pulp that has been destroyed is largely man's product developed by him through long years of selection and culture, and for which the orchard is planted and preserved. Nature wants more apple seed; man desires more and better pulp. Nature claims that the pulp of the wild apple is only to secure the wider dissemination of the seed, and to the orchardist, middleman, and consumer she speaks in her emphatic way that "if you would exact of me extra-fine pulp, you must at the same time employ the best devices of your high civilization to preserve it from your omnipresent and active competitors, the insidious germs of decay."

THE DISCOVERY OF ALCOHOL AND DISTILLATION.

By M. P. E. M. BERTHELOT.

ALCOHOL is an important factor in modern civilizations, the source of great revenues to states, and of immense wealth to those who deal in products containing it. While wine, beer, hydromel, etc., have been in use from prehistoric times, the active principle common to them which produces the pleasant excitement and the disgusting intoxication, and which is concentrated in spirituous liquors, alcohol, has been known for only seven or eight centuries; it was unknown in antiquity. The story of the way the discovery of it was made is one of much interest.

The reservation of the name of *alcohol* for the product of the distillation of wine is modern. Till the end of the eighteenth century the word, of Arabic origin, signified any principle attenuated by extreme pulverization or by sublimation. It was applied, for example, to the powder of sulphuret of antimony (*koheul*), which was used for blackening the eyes, and to various other substances, as well as to spirits of wine. No author has been found of the thirteenth century, or even of the fourteenth century and later, who applied the word alcohol to the product of the distillation of wine. The term *spirit of wine* or *ardent spirit*, although more ancient, was also not in use in the thirteenth century; for the word spirit was at that time reserved for volatile agents, like mercury, sulphur, the sulphurets of arsenic, and sal ammoniac, which were capable of acting on metals and modifying their color and properties. The term *eau-de-vie* was given in the thirteenth and fourteenth centuries to the elixir of long life. It was Arnaud de Villeneuve who employed it for the first time to designate the product of the distillation of wine. But he used it, not as a specific name, but in order to mark the assimilation which he made of it with the product drawn from wine. The elixir of long life of the ancient alchemists had nothing in common with our alcohol. Confusion of the two has led the historians of science into more than one error.

Our alcohol first appeared under the name of inflammable water, a name which was likewise given to spirits of turpentine. Let us try to determine, from the ancient authors and those of the middle ages, what was the origin of the discovery of alcohol, and to trace the successive steps in the knowledge of that substance. The ancients observed that wine gave out something inflammable. We read in Aristotle's *Meteorologica*, "Ordinary wine possesses a kind of exhalation, and that is why it gives out a flame." Theophrastus, an immediate disciple of Aristotle's, says, "Wine poured upon the fire, as for libations, throws out a light"

—that is, produces a shining flame. Pliny says, still more decidedly, that the Falernian wine, the product of the Faustian field, is the only wine that can be ignited "on contact with a flame"; a thing that happens with some wines very rich in alcohol. These are common phenomena, accidental observations made in the course of sacrifices and festivals which served as the beginning of the discovery. But there had to be many intermediate steps. Among them was this experiment, an amusing trick in physics, doubtless devised by some prestidigitator, which is explained in a Latin manuscript in the Royal Library of Munich: "Wine can be burned in a pot, as follows: Put white or red wine in a pot, the top of the pot being raised and having a cover with a hole in the middle. Having heated the wine till it begins to boil and the vapor comes out through the hole, put a light to it. The vapor will at once take fire and the flame will last as long as it comes out." But alcohol was not isolated by the ancients.

Distillation, or a method of separating the inflammable principle from wine, had to be discovered before a further knowledge of alcohol could be gained. This process passed through several stages. It also started from common observations. When water is heated in a vessel, its vapor condenses on the walls of surrounding objects, and especially on the cover of the vessel; this can be observed by every one, in domestic economy, on the covers of soup dishes, of kettles, and of tea and coffee pots. Aristotle mentions the fact in his *Meteorologica*. "Vapor," he says, "condenses under the form of water, if we take pains to collect it." He speaks in another place of a less usual observation, which was probably likewise accidental, and which has been extensively applied in our own time. "Experiment has taught us that sea-water when converted into vapor becomes potable, and the vaporized product, when condensed, no longer resembles sea-water. . . . Wine and all liquids, when vaporized, turn into water." It appeared, then, according to Aristotle, as if evaporation changed the nature of the vaporized liquids and reduced them all to an identical condition—that of water. This change was conformable to the philosophical ideas of the author, wine and sea-water being reduced to the same condition of water, the principle of liquidity, which was regarded by the ancient philosophers as one of the four fundamental elements of things.

Aristotle's remarks on sea-water soon gave the suggestion of a practical process mentioned by Alexander of Aphrodisias, one of his earliest commentators, about the second or third century A. D. According to that author, sea-water was heated in brass kettles, and the water that condensed on the covers was collected for drinking. This was the germ of the industry of the distillation of sea-water, which is practiced now on a large scale on board of ves-

sels. But, before this process could be carried out in a practical form, the modern improvements in the process of distillation had to be discovered.

Similar processes to that mentioned by Alexander of Aphrodisias are described by Dioscorides and Pliny, in the first century A. D., for the preparation of two liquids so different as mercury and spirits of turpentine. These discoveries, also met in accidental observations, began to make more general the ideas of the industrial men and physicists of the time. Cinnabar, or sulphuret of mercury, has been used from remote antiquity as a red coloring matter (vermilion); the Romans got it from Spain, where the principal mines of mercury in Europe are still situated. It was early remarked that, in heating in an iron vessel to purify it, it disengages vapors of mercury, which are condensed on neighboring objects, chiefly on the cover of the vessel. This discovery was the origin of the regular extracting process, described by Dioscorides and Pliny. The cinnabar was placed in a capsule of iron in the middle of an earthenware pot. The cover was sealed on, and heat was applied. After the operation the cover was scraped, in order to detach and collect the globules of mercury which had sublimed from the capsule. Thus was obtained artificial quicksilver, which the ancients supposed to have different properties from natural quicksilver, or that which occurs in Nature in mines. This was an illusion, the mercury being identical, whatever the mode of extraction. At any rate, the process employed for the extraction of mercury by vaporization is the same as that described by Alexander of Aphrodisias for making sea-water potable; and this process, as I shall shortly explain, was the beginning of the alembic.

Another rudimentary process, the first that was applied to the extraction of an essential oil, is described by Dioscorides and by Pliny. It is for the distillation of pine resins, which are now called turpentines. They were heated in vessels over which wool was spread; this condensed the vapor; then the wool was pressed, in order to extract from it the liquefied product, spirits of turpentine, which was then called resin oil or flower of resin. It soon assumed an important function in the composition of the inflammable substances used in the arts and in war. But these terms seem at first to have designated also and at the same time the most liquid part of the resins, as well as the water charged with their soluble principles, which was floating on these resins like whey on milk, at the moment of their extraction; and, lastly, the distilled and odorous water which was vaporized at the same time with the essence. The ancients were in some confusion about these substances, which are distinct in modern chemistry; and this it is which makes the reading and interpretation of the old authors so hard.

The decisive step in the knowledge of distillation was taken in Egypt. There were invented the first real distilling apparatus during the first centuries of the Christian era. They are described precisely in the works of Zosimus, an author of the third century, from the technical treatises of two women chemists named Cleopatra and Mary. In the margin of a Greek text of St. Mark are the drawings of the apparatus, and they agree exactly with the author's descriptions. The apparatus consists of a boiler or balloon-shaped receiver, in which the liquid was put; but the cover was replaced by a large tube topping the balloon, and ending above in a cap shaped like an inverted balloon, to serve as a condenser. The cap was furnished with lateral conical tubes inclined downward, which were intended to collect the condensed liquid and allow it to flow out into small bottles. All the essential parts of a distilling apparatus are here defined. These lateral tubes and their recipients constitute the chief improvement, and are what constitutes the alembic. Among the distinctive characteristics of the primitive alembic described by Zosimus is the multiplicity of the abductor tubes. He distinguishes between two-beaked and three-beaked alembics. The flow of vapor was simultaneous, though there were several beaks, and condensation took place in two or three receivers at once. Another figure represents an alembic with a single beak, to which a large copper tube was attached. An alembic described by Synesius, an author of the fourth century, and figured in less ancient manuscripts, shows the boiler with its cap, furnished with a single tube, the whole apparatus being heated in a marine bath. This form varied but little till the sixteenth century. The alembic passed from the Greco-Egyptian experimenters to the Arabs without any notable change. The Arabs were not, therefore, the inventors of distillation, as has been too often affirmed. In chemistry, as in astronomy and medicine, they merely reproduced the apparatus and processes of the Greeks, their masters, adding a few improvements in details. It is a mistake to trace the discovery of distillation and of alcohol to Rases, or Abulcasis, or other Arabian authors; the verified texts have at least furnished me no indication of that kind. In fact, Rases (tenth century), in the passages cited in support of that opinion, speaks only of vinous liquids or false wines obtained by the fermentation of sugar, honey, and rice; liquids, some of which, like hydromel, were known to the ancients. But there is nothing about distilling them, or extracting a more active principle, in any passage in Rases that I am acquainted with. In the pharmaceutical works attributed to Abulcasis or Abulcasim, a Spanish doctor of Cordova, who died in 1107, we only find a distilling apparatus for preparing rose-water which did not differ in principle from those of the old Grecian alche-

mists. The Arabs, therefore, were still, in the beginning of the fourteenth century, using the complicated apparatus of the Greco-Egyptians.

Alembics with several beaks were still employed by the Western alchemists in the sixteenth century. In Porta's treatise, entitled Natural Magic, a collection of processes or secret operations, the author mentions the cap of three and four beaks, each furnished with its tube and receiver. It is still the old apparatus of Zosimus. Porta, however, describes two important improvements which have come down to modern industry—graduated condensations during the same operation and the cooling worm. We need not suppose that he invented them, but only that he described the practice of his time. The new feature is as follows: In the alembics described by Zosimus the three pipes are at the same level, and doubtless disengaged an identical vapor; the ideas of the chemists of the time were too vague to allow anything else to be expected. The three tubes of Porta, on the other hand, are at different heights, and the author adds that the highest tube furnishes the purest spirit. We can already discern the ideas that have fructified in our apparatus for fractional rectification, with series of superposed chambers and trays delivering alcohols of higher degrees of concentration from the higher levels. This arrangement, however, was abandoned; at least we find no more trace of it during the following centuries. In this as in many other incidents, the men of the sixteenth century foresaw the most modern advances, but by a kind of intuition, without their having those clear notions and those exact principles of physics which, being wanting, progress is accidental and transient.

Another more durable improvement was that of the worm. The alembics of the ancient Greeks doubtless permitted distilled liquors to be obtained, but on condition of operating slowly and with a very moderate heat. In fact, the vapors were imperfectly condensed on the small surfaces of the tubes and the caps represented in the manuscripts. However little we might try to hasten the distillation, the receivers would become warm and condensation would become almost impossible. Hence the ancient authors prescribed that their apparatus should be heated over very slow fires. They operated by means of sand baths, baths of ashes, or water baths. Sometimes they tried to distill with no other heat than that of fermenting manure or a low fire of dung or sawdust. Their operations were therefore very slow, and often lasted for days and weeks. It required fourteen days, or twenty-one days, a text would say, to perform the operation. Not only did they in this way assure the effect of digestions and cementations, designed to produce gradual permeation with sulphurous and arsenical vapors, into sheets of metal submitted to the tinctorial action of

the elixirs, but they also made it practicable to collect the liquids placed in the alembics.

At last, however, the operators of the middle ages perceived that the manipulations could be conducted more rapidly, the distillations, for instance, by cooling the cap and the connected tube that conducted to the last receiver. For that purpose they first fixed around the boiler cap a bucket filled with cold water; this facilitated the condensation, but caused a part of the liquefied vapors to fall back into the boiler. A new improvement—the one described by Porta—consisted in bending the tube between the cap and the receiver and giving it the form of a serpent. This was the origin of the modern still-worm. It was surrounded by cold water in a wooden vessel. But the use of the serpentine arrangement spread very slowly, and was still regarded as recent by the authors of the eighteenth century.

Let us observe here that we are using the word distillation in the modern sense of evaporation followed by a condensation of liquid; but in many authors of the middle ages the sense is more vague. The word means, in its literal sense, a flow drop by drop, and is applied equally to filtration and all refining and purification. The word distill is often employed in the same sense in modern language. It also comprehended from the Greco-Egyptian epoch two fundamentally distinct operations, viz., the condensation of dry vapors into a solid form—such as calamines or metallic oxides, sulphur, metallic sulphurets, arsenious acid and metallic arsenic (which was the second mercury of the Grecian alchemists), and at a later date chlorides of mercury, sal ammoniac, etc.—the process which is now called sublimation. It requires special apparatus, which the ancients devised and used, and which gave rise to the Arabian aludel. We mention this here on account of its connection with many modern industries, although it has no relation to the discovery of alcohol.

I proceed now to describe distilled liquids and the successive steps made in their study. "Celestial things above, terrestrial things below," was the phrase by which the Grecian alchemists designated the products of all distillation and sublimation. They declared that "the sublimed vapor emitted from below up is called divine. . . . White mercury is likewise called divine, because it, too, is emitted from below up. . . . The drops which affix themselves to the covers of boilers are likewise called divine." In this expression we find the marks of Aristotle, Dioscorides, and Alexander of Aphrodisias. The alchemists, according to their usage, interpreted these purely physical ideas by symbols and a curious mysticism. Democritus (or the alchemic author who took that name) called the spherical apparatus in which the distillation of water was carried on "celestial natures."

The separation which is effected in these between volatile water and fixed matter is expressed as follows in the text of Olympiodorus, who lived at the beginning of the fifth century: "Earth is taken in the early morning, still impregnated with the dew which the rising sun lifts with its rays. It is then like a widow and deprived of its spouse, according to the oracles of Apollo. . . . By divine water I mean my dew, aërial water." In the same style Comarius, a writer of the seventh century, drew the allegorical picture of evaporation and the condensation that accompanies it, condensed liquids reacting on the solid products exposed to their action: "Tell us . . . how the blessed waters descend from above to visit the dead, stretched out, chained, and loaded down in darkness and shadow, in the interior of hades; . . . how new waters enter in, . . . come by the action of the fire; the cloud holds them up; it rises from the sea, sustaining the waters."

This singular language, this enthusiasm borrowing the most exalted religious formulas, need not surprise us. The men of that time, excepting a few superior geniuses, had not reached that state of calm and abstraction that permits the contemplation of scientific verities with a serene coolness. Their education, the symbolical traditions of ancient Egypt, and the gnostic ideas with which the first alchemists were all impregnated, did not allow them to preserve their even balance. They were transported and intoxicated, as it were, by the revelation of that hidden world of chemical transformations which appeared to the human mind for the first time.

In the first Greek treatises, all the active liquids of chemistry are confounded under the common name of divine water or waters. "Divine water is one in kind," they said; "but it is multiplied as to species, and admits of an infinite number of varieties and methods of treatment." They designated those varieties by the most various symbolical names, such as aërial water, fluvial water, dew, virginal milk, water of native sulphur, silver water, Attic honey, sea-foam, etc. Confusion was systematically engendered by this variety of denominations, for the avowed purpose of concealing the secrets of the alchemical fabrications from the vulgar and uninitiated. Although it is occasionally possible to discern something precise in the deliberate vagueness of the descriptions, there does not exist among them, so far as I know, any text that is applicable to the distillation of wine. It is barely possible that the principle of fractional distillation and the diversity of its successive products are indicated in one or two passages, but those passages appear to apply to the treatment of alkaline polysulphides or of organic sulphureted substances, which have nothing in common with alcohol.

I have not, moreover, met in the Arabic treatises on medicine

and *materia medica* as yet printed, or in the manuscript Arabic works of Geber and other alchemic authors which I possess and am preparing for publication, with any precise text relative to alcohol or to any definite distilled liquid. I have already explained the passages of Rases that have been wrongly cited as bearing on this point, which relate only to fermented liquids without reference to their distillation or to the extraction of alcohol. So Abulcasim, who has been cited, after describing some distilling apparatus modeled after the *dibicos* and *tribicos* of the Greeks, adds simply, "According to this method, whoever wants distilled wine can distill it." He gives directions for distilling rose-water and vinegar in the same way. He speaks only of distillation in a mass. Still, the idea of the preparation of a distilled fragrant water, like rose-water, appears here clearly for the first time; but there is nothing in it that applies to an essence proper, or especially to alcohol.

I repeat that simply a distillation of wine, without any distinction between the successive products of a fractional distillation, is meant in these texts. But it was perceived from that time, contrary to the opinion of Aristotle, that distilled wine was not identical with water; still, our authors do not speak of alcohol, although the knowledge of that substance would result almost immediately from the study of the distilled liquids yielded by wine.

The most ancient manuscript containing a precise reference to this product is in the *Clef de la peinture*, which was written in the twelfth century. It is a receipt in cipher, which when deciphered and translated reads: "By mixing pure and very strong wine with three parts of salt and heating it in vessels designed for the purpose, we obtain an inflammable water, which is consumed without burning the matter on which it is placed." This meant alcohol. The property of burning on the surface of bodies without burning them greatly struck the first observers of it. A more explicit mention is contained in the Treatise on Fires of Marcus Græcus, a Latin work drawn from Arabian and Grecian sources, no manuscripts of which, however, are of earlier date than the year 1500. It is a compilation of technical receipts, mostly relating to the art of war. The receipt for the burning water was added later to the original text; for it is not a part of another manuscript that exists in Munich, but is inserted in it outside of and after the Treatise on Fires. It contains some new hints and characteristics, and is as follows: "*Preparation of Inflammable Water.*—Take wine, black, thick, and old. For a quarter of a pound add two scruples of very finely powdered sulphur, one or two of tartar, extract of a good white wine, and two scruples of common salt in coarse fragments. Place the whole in a

good leaden alembic; put on the cap, and you will distill the burning water. It should be kept in a glass vessel tightly closed." The Munich manuscript adds: "These are the virtue and properties of the inflammable water: A rag moistened with it and set on fire will burn with a great flame. When the fire is extinguished the cloth will be found unharmed. If you dip your finger in this water and then put fire to it, it will burn like a candle and not suffer any wounding." This was in fact a prestidigitator's trick; and the part those people played is manifest in the beginnings of a large number of inventions in antiquity and the middle ages. In any case the facts pointed to in this description are exact, and show how first observers are often struck by real or apparent properties of bodies, even though they be insignificant. Frequently, too, they complicate operations by superfluous if not annoying details, to which, according to the theories by which they are guided, they attach the same importance as to the rest. For instance, in the first receipt of Marcus Græcus is a direction to add sulphur previous to the distillation, which occurs likewise in a book by Al Farabi, transcribed into another manuscript of the same period, as well as in Porta's Natural Magic, which was composed in the sixteenth century. It is therefore not accidental. It is the product of a theory which is expounded at length in several texts, held by the chemists of the time, that the great moisture of wine is opposed to its inflammability. To counteract this they added salts or sulphur, the dryness of which, they said, augmented the combustible properties. One of these old authors refers, in support of his theory, to dry wood and green wood, unequally combustible, according to the season when they were cut and the proportion of moisture they contain.

We should recollect also that volatility and combustibility were then confounded and called sulphurity, a term which was still applied in this sense in the time of Stahl, at the beginning of the eighteenth century. These ideas go back to the Grecian alchemists, who called every volatile liquid and every sublimate sulphurous (or divine) water. In this we can see the origin of those complicated preparations, so hard to understand now, which were employed by the old alchemists. They tried to communicate to bodies the qualities in which they were lacking by adding to them substances in which those qualities were supposed to be concentrated. Hence sulphur was added to wine in the belief that it would render the manifestation of its inflammable principle easier.

The first man of science known by name who spoke of alcohol is Arnaud de Villeneuve, who was of a date posterior to the composition of these writings. He is commonly spoken of as the author of the discovery, though he never himself presented such a claim. He only spoke of alcohol as a preparation known in his

time, which he admired very much. He recorded of it in his work Concerning the Preservation of Youth: "We extract, by distillation of wine or its lees, burning wine, called also *eau-de-vie*. It is the most subtile portion of the wine."

He then exalts its virtues: "*Discourse on Eau-de-vie.*—Some call it water of life; some of the moderns say it is permanent water, or rather golden water, on account of the sublime nature of its preparation. Its virtues are well known." He next enumerates the maladies for which it is a cure: "It prolongs life, and therefore deserves to be called water of life. It should be kept in a golden vessel; all other kinds of ware, except glass, are liable to be acted upon by it." Then he speaks of alcoholates: "On account of its simplicity, it receives every impression of taste, odor, and other properties. When the virtues of rosemary and sage are imparted to it, it exercises a favorable influence on the nerves," etc. The pretended Raymond Lulle, a more modern author than Arnaud de Villeneuve, speaks of alcohol with equal enthusiasm. He describes the distillation of the inflammable water, derived from wine, and of its rectifications, repeated seven times if necessary, till the product burns without leaving a trace of water, and adds, "It is called vegetable mercury." So it appears that the alchemists in the beginning of the fourteenth century were taken with such admiration for the discovery of alcohol that they likened it to the elixir of long life and the mercury of the philosophers. Yet we have to be cautious against taking every text concerning the mercury of the philosophers or the elixir of long life as applicable to alcohol.

The elixir of long life is a fancy of ancient Egypt. Diodorus Siculus calls it "the remedy of immortality." Its invention is attributed to Isis, and the composition of it may be found in the works of Galen. The formulas for it in the middle ages were various. It was also reputed to be capable of changing silver into gold, or, in other words, was credited with the same chimerical properties as the philosopher's stone.

Although the discovery of alcohol did not give realization to these illusions, it has nevertheless had the gravest consequences in the history of the world. Alcohol is an eminently active agent, and thereby at once useful and harmful. It may prolong human life or shorten its term, according to the use that is made of it. It is also a source of inexhaustible wealth for individuals and states—a more fruitful source than the pretended philosopher's stone of the alchemists could have been. Their long and patient labors were therefore not lost; and their dreams have been realized beyond their hopes by the discoveries of modern chemistry.—*Translated for The Popular Science Monthly from the Revue des Deux Mondes.*

TRIBUTE OF THE FRENCH ACADEMY TO AMERICAN GEOLOGICAL EXPLORATION.*

THE following tribute to the Americans who have conducted meritorious geological and geographical explorations is a graceful and well-bestowed recognition from the French people of the remarkable results that have been achieved in this country by individual and Government agencies in adding to the sum of human knowledge. The tribute of words is even more beautiful than the elegant medal which accompanied it, and while the United States Geological Survey is made the official recipient of the gift, it will be seen that it is intended to honor other American workers in this field of science.

Institute of France, Academy of Science. Meeting of December 21, 1891. Pages 70 to 74.

CUVIER PRIZES.

COMMISSIONERS: MM. GAUDRY, FOUQUÉ, DE QUATREFAGES, MILNE-EDWARDS. M. DAUBRÉE, RAPPORTEUR.

The commission charged with awarding the Cuvier prize for the year 1891 has with unanimous voice given this high mark of esteem to the collective work of the Geological Survey of the United States.

In the United States, where all the natural resources are exploited with so much ardor, the studies relative to the soil ought necessarily to demand a very particular attention by reason of the numerous applications which they legitimately promise. It is therefore more than half a century since the governments of many States instituted a geological exploration of the lands which belonged to them. These geological surveys were organized and confided to men most prominent in their profession. It was in the Northern States that the most considerable progress was made. Hitchcock published, in 1833, the Geology of Massachusetts. From 1836 to 1840 the eminent Henry Rogers and his brother, W. B. Rogers, undertook that of Pennsylvania and Virginia, the essential characteristics and distorted structure of which they so admirably made known. Charles T. Jackson, of Boston, the discoverer of etherization, and already known by his mineralogical works, undertook that of Maine, New Hampshire, and Rhode Island (1837 to 1839), after having published in 1833 a study of Nova Scotia. The geology of the State of New York is confided to James Hall—who has not yet discontinued the series

* Translated by Robert T. Hill, of the United States Geological Survey.

of his discoveries—Mather, Emmons, and Vanuxem. It has given existence to publications that have become classic (1836 to 1842). By the side of these promoters who have the merit of having been the first to conquer the greatest difficulties, justice demands that there should be written the names of two geologists not attached officially to the service of the United States, whose powerful influence ought to be proclaimed. Our compatriot De Verneuil pursued since 1846, with the success that is well known, a task which no other could better undertake, that of comparing upon the two continents all the sedimentary deposits, from the most ancient down to those that contain the coal; and Dana, by his original work and by his excellent books, has contributed singularly to the education of all those who, in Europe as well as in America, devoted themselves and still devote themselves to the study of geology and mineralogy.

The first results attained proved the utility of like enterprises. Thus, following the steps of the local governments, the Federal Government entered into the same path.

It was at first for the great Territories of the West, little known and not yet classed as independent States. The wise geologist Hayden, to whom this study was confided and of whom we deplore the loss, worked there with ardor during a dozen years. First of all had to be adopted a rational plan for an exploration at the same time geographic and geologic. This new service bore, indeed, the title of Geological and Geographical Survey of the Territories. Then followed the discovery in 1871, and the detailed exploration in 1872, of the region of the geysers of the Yellowstone; from 1873 to 1879 the complete topographic and geologic survey of the Alpine part of the Rocky Mountains comprised in the State of Colorado. The atlas which unites all these researches (1877) is a *chef-d'œuvre* of cartography; it is in great part the work of Mr. Holmes, the artist-geologist, of whom one admires the incomparable sketches scattered in profusion through the official publications.

In order to explore the Rocky Mountains (1869 to 1875), Mr. J. W. Powell descended by water the celebrated and dangerous cañons of the Colorado, and made a report which has become classic on the phenomena of erosion. During the same epoch Mr. Gilbert made an extremely remarkable study of the Henry Mountains.

At the same time the Engineer Department of the United States Army was charged with work of the same class over an immense country still little more than desert and very little known. The title of this new service, "Geological and geographical exploration and survey of the one hundredth meridian," shows that, in this case also, the examination of the constitution of the

soil marched side by side with the study of its topography and relief. This important mission was placed, in 1872, under the direction of Lieutenant Wheeler, who in the preceding year had explored a portion of Nevada and Arizona. The choice could not have been better, as is proved by the career since then of the distinguished engineer. His purpose was to reconnoitre the natural resources of the mountainous country in the neighborhood of the chosen parallel, and also of the great railroad lines of the Union and Central Pacific between the one hundred and fourth and one hundred and twentieth degrees of longitude west from Greenwich. After having examined the Sierra Nevada and the Coast Ranges, Prof. Whitney, Director of the Geological Survey of California, pushed his investigations toward the Pacific slope. But, between California on the west and the base of the Rocky Mountains on the east, exploited by Hayden, there remained a vast gap of sixteen degrees of longitude which was little known. Under the direction of Mr. Clarence King this gap was very well filled. A general knowledge was acquired of the great mountain system of North America and that in its greatest expansion. We possess now results sufficient to make clear the important problem of the dynamics of mountain chains.

Since 1879 all the geological studies executed at the expense of the central Government have been confided to a single administration bearing the title of the Geological Survey.

Organized by Clarence King, it passed in the following year under the direction of J. W. Powell, in whose able hands it has since remained. Its end, as is defined by the organic law, is the reconnoissance of the geological structure of the country, of its mineral resources, and finally the execution of a geologic map.

The researches carried forward in very different directions of science have been apportioned to many divisions: Geography, geology, paleontology, and others. Geologists, to the number of about twenty, are each one charged with special functions, and their results are gathered each year into a report of the director under the name of Annual Report. It is a large volume published in magnificent shape, in which are likewise collected memoirs upon divers subjects, with an accompaniment of numerous maps, engravings, and photolithographs. Already ten annual reports have appeared.

Besides these reports the survey has published from time to time monographs upon subjects particularly interesting, likewise under the form of very beautiful volumes, accompanied with many figures, and occasionally by a voluminous atlas.

Also under the title of bulletins, of which already have appeared sixty papers relating to subjects new and interesting. And, finally, a statistical publication bearing the name of Mineral

Resources of the United States appears annually and makes known not only the figures of production but also the numerous theoretical considerations which interest the miner.

As to the geographic work which the Geological Survey also possesses among its attributes, a numerous *personnel* of topographers and engineers work actively at the execution of the map in the most diverse parts of the country under the direction of Mr. H. Gannett. Already more than six hundred sheets have been surveyed and drawn, and about four hundred have appeared.

Besides geology and geography ought to be mentioned a considerable work, of which Mr. Powell is the founder, in the domain of the pre-Columbian archæology, the linguistics, the ethnology, and the anthropology of the Indians of North America, splendidly illustrated by Mr. Holmes. The last publication of Mr. Powell upon the classification of American languages is, according to the best judges, of great importance.

Not being able to give here a complete list of all the actual collaborators of the survey, or of their services, we must content ourselves with noticing those who have taken the principal part in the execution of the works already published. These are in alphabetical order: Messrs. Becker, Chamberlin, Cross, Davis, Day, Diller, S. F. Emmons, Fontaine, Gannett, Gilbert, Hague, Hayes, Holmes, Iddings, McGee, Marsh, Newberry, Peale, Russell, Shaler, Van Hise, Walcott, Ward, Upham, Weed, C. A. White, Whitfield, A. Williams, G. H. Williams, and H. S. Williams. It is but just that we should not omit the names of those who are dead: Messrs. Hayden, Irving, Lesquereux, Leidy, Marvine, and Newton; or of those who no longer belong to the survey: Messrs. Bradley, Cope, Curtis, Dutton, Endlich, Hill, Howell, Clarence King, St. John, Stevenson, and Wheeler. Many of these names will remain justly illustrious.

It will be impossible to give in this report even a summary idea of the most remarkable discoveries which are due to the Geological Survey. They belong to branches very diverse: regional geology, monographs concerning metalliferous deposits, general and comparative stratigraphy, mineralogy and petrography, volcanic phenomena, glacial phenomena, ancient Quaternary lakes, and a history of the Atlantic littoral.

Among the most considerable results must be mentioned the paleontological discoveries made in the Rocky Mountains. Since the day in which Hayden undertook his memorable explorations, we have learned that the site of the Rocky Mountains was continuously a part of the continent during the greater portion of the Secondary, Tertiary, and Quaternary epochs. Upon this vast continent the quadrupeds could develop during extended time, freely, without any interruption to their evolution, and thus they

became numerous, gigantic, and sometimes strange. The paleontologists attached to the Geological Survey have brought to light these curious creatures. The monographs of the regretted Leidy, of Cope, and of Prof. Marsh are among the most beautiful paleontologic works accomplished since Cuvier.

Magnificent researches have also been made concerning the invertebrates and the fossil vegetables.

To resume, under the powerful impulse which the Federal Government has given to it, the geologic service of the United States has produced in twenty-five years results very considerable and very skillfully attained. It must be said that in no other region of the globe have been made such discoveries in so short a space of time. Moreover, this organization, all perfect as it is, could not have given such fruits if the galaxy of *savants* who have taken part in it had not given proof, at all times, of a valor and of a tenacity which, in the diverse and inhospitable regions in which they were exercised, recall the heroism of an army attacking the most arduous and most inaccessible obstacles.

The work of the Geological Survey, with the magnificent collection of results that it comprises, merits then that we should render to it a striking homage for the light so vivid and so unexpected that it has thrown upon the geologic history and the mineral riches of North America.

The Cuvier prize is decreed to this grand collective work, not only to the actual collaborators, but also to those who have ceased their labors. It will, we hope, be preserved in the archives of the Geological Survey as a witness of the high esteem of the Academy of Sciences.

His studies of the planet Jupiter for the past thirteen or fourteen years have satisfied M. Terby that the conditions existing there are more stable than astronomers have of late years been supposing. Even if the phenomena of the spots and bands are atmospheric, their permanency and regularity point to some fixed cause, on the real surface of the planet, controlling them. Besides the "red spot," which has now attracted attention for many years, he finds permanent spots, even on the equatorial zone, having a movement of rotation corresponding with that of this object. The supposition may be legitimately drawn from this fact that this period of rotation agrees with that of the rotation of the planet itself.

At present, the Hon. Rollo Russell contends, in his book on the Causes and Prevention of Epidemic Plagues and Fevers, the science of "public life-saving" is far ahead of the practice. We teach, he observes, in compulsorily attended schools the names of "ancient and unworthy kings," of lakes, mountains, rivers, and so on; while we neglect to instruct in the weightier matters that concern life, health, prosperity, and happiness. The remedy lies in placing the knowledge of the first principles of hygiene within the acquisition of every person of the community.

HOW SCIENCE IS HELPING THE FARMER.

By CHARLES S. PLUMB, B. S.,
DIRECTOR INDIANA AGRICULTURAL EXPERIMENT STATION.

A SCORE or more years ago, when Horace Greeley and Henry Ward Beecher were telling the American public what they knew about farming, there was quite a general tendency on the part of the agricultural class to hold up to ridicule what was termed "scientific farming." Great claims were then made as to the importance of a knowledge of science, so that the farmer might analyze the soil, crops, fertilizers, etc. Especial stress was laid upon having a knowledge of chemistry, in order to be able to analyze something. Chemistry was to be the panacea for all the farmer's ills, and writers indiscriminately quoted Liebig, Boussingault, Johnston, Lawes, and Gilbert, and other famous agricultural chemists. There was much book farming done that was a source of amusement for practical agriculturists. Much of the written matter and advice published was worthless, and time and the labors of science conclusively demonstrated as much. Early investigators, engaged in faithful and hard work, gleaned much information of scientific importance, and eventually overturned numerous theories that had hitherto seemed plausible. Chief among these was the analysis of soils, whereby one could know the composition of his soil and at once determine in what ingredients of plant food it was deficient, so that he might feed back to it the lacking elements. Time and study have shown that soil is a very complex substance, and one analysis is usually quite unsatisfactory, because a little sample of soil represents only a small piece of ground, perhaps representing quite unfairly the entire field. Consequently, as remarked by Dr. Caldwell,* soil analyses are not thoroughly practical, on account of the difficulty in securing a sample of a few pounds that shall correctly represent the millions of pounds of soil in even a single acre, to say nothing of a field of many acres.

Fifty years ago Justus von Liebig, a German chemist, through an interest in rural economy which resulted in far-reaching discoveries, established himself as the father of agricultural chemistry. His investigations largely related to the composition of the soil and plant nutrition. He was the first to prove that plants fed on certain ingredients of the soil, and that different classes of soils and plants varied in their composition. Liebig's was the pioneer work, and from his time to the present a mass of scientific information has been gradually accumulating that in numerous ways is serving a good purpose.

* Agricultural Science, vol. i, p. 25.

Never before in history have scientific workers been so practical as now. We live in essentially a practical age, and men live better, more intelligently, and more easily than ever before. Practical problems engage the attention of the scientist over all others; and so, instead of ridicule, science as applied to the farm is now receiving most respectful consideration, for the work is practical, and sound practice always receives respectful attention.

Science is knowledge. There is no scientific farming. The highest type of farming is intelligent farming. The intelligent farmer of to-day is simply making use of certain scientific facts that have a practical application.

For a half century science has been laboring in the interests of agriculture. This year the United States appropriates nearly one million dollars for scientific experimentation as applied to agriculture. And yet but few farmers realize how material is the assistance being given the agricultural classes of the country through the direct application of accomplished scientific work. In view of this condition of affairs, in the following pages I propose to give illustrations of what is now in practical use, showing how science has helped and is helping the farmer. These examples signify something. They mean a saving of millions of dollars to the people of the country. Millions have been saved to the farmers in the past; millions will be saved in the future; and all through the aid of scientific research.

The first real substantial assistance received by the farming public from science was in the examination and inspection of commercial fertilizers. Liebig demonstrated that plants secured most of their nutrition from soil ingredients. Nitrogen, potash, and phosphoric acid were those most in demand by the plant, and where crops were removed from the soil these articles of plant food were diminished, thereby reducing cropping capacity. Soil exhaustion in a measure followed if these substances were not returned to feed subsequent crops. Natural manures (animal excrement) contained nitrogen, potash, and phosphoric acid; consequently soil fertility could be maintained by the application of these. But chemistry here came to the farmer's aid, by suggesting that the various essentials of plant food be supplied in artificially prepared form. Nitrogen could be obtained from Peruvian guano and animal matter, potash from wood ashes or German salts, and phosphoric acid from bones; consequently these substances could be supplied as desired. With the propagation of this idea was developed the commercial fertilizer, and artificial manures were made and sold on the market as is any other commodity. However, it was not long before much fraudulent material found its way into the buyer's hands; many dealers were not honest, and farmers were often outrageously swindled. Here,

again, the chemists came to the assistance of agriculture. Fertilizers could be analyzed, their component parts determined, and purchasers might learn how many pounds of plant food a ton of artificial manure contained. Nitrogen, potash, and phosphoric acid each had a commercial value per pound; consequently the chemist could easily determine in a fair manner the value of a ton of fertilizer.

In 1872, through the efforts of Dr. C. A. Goessmann, Professor of Chemistry in the Massachusetts Agricultural College, the Massachusetts Legislature passed a law appointing a State inspector of fertilizers, requiring that all fertilizer manufacturers making a fertilizer having a valuation of over twelve dollars a ton should print on a tag attached to the bag or barrel containing the same the percentage of nitrogen, potash, and phosphoric acid in the brand sold. Samples of all fertilizers selling for over twelve dollars per ton had first to be analyzed by the State chemist before they could be sold in the market; and this officer, designated "inspector," was authorized to sample and analyze any or all fertilizers sold in the State. This Massachusetts law was at first more or less imperfect, but it was later on amended and made eminently satisfactory to both the manufacturer and the consumer. Other States followed the example of Massachusetts, and to-day there is not a State in the Union handling fertilizers to any extent that has not upon its statute-books laws patterned to some degree after the Massachusetts idea, and as a result manufacturers can not with safety sell the farmers shoddy fertilizers. Now and then a fraudulent fertilizer appears, but its sale is quickly stopped by the chemist's exposure. Only a short time ago (the summer of 1890) two fertilizers were suddenly placed upon the Indiana market and sold for $27.50 and $22.50 per ton, respectively. These were analyzed by the State chemist, and the former was found to have a value of $5.76 and the latter of $4.44 per ton. These were out-and-out swindles; yet, had it not been for a prompt publication from the State Experiment Station at Purdue University as to their real character, many farmers of the State of Indiana would have been unmercifully swindled. In view of the fact that millions of dollars' worth of fertilizers are sold yearly in the United States, one can readily understand how great is the sum of money that is being yearly saved to the farmers of the country through the interposition of the chemist.

In the Eastern and more populous part of the United States, which has been long under cultivation, farm manures are more highly valued than in the newer regions of the country. For years investigators have advised that stable manure be handled economically. Chemists argued that, unless properly protected, these manures would lose much of their valuable properties,

mainly through rain leaching away the soluble plant food. Figures supplied from foreign investigation were used to prove the point. Finally, in 1889 the Cornell University Agricultural Experiment Station did some practical work to demonstrate how farmyard manure would deteriorate by leaching and fermentation.* It was shown that one ton of fresh horse manure had a valuation of $2.45, but exposed outdoors for six months its valuation was $1.42, a loss of $1.03 per ton, or forty-two per cent. Mixed horse and cow manure, after leaching for six months, showed a loss of 9·2 per cent, a less amount, no doubt, than occurs on the average farm.

At the present time, while there is a vast loss of plant food to the farms through the improper care of the manure produced thereon, there is at the same time saved to economic use an enormous amount of fertility through the careful husbanding of the materials as produced upon the farms of those who are intelligent and economical. We must give scientific investigation the credit for thus showing husbandmen how important farm losses may be prevented; the numerous devices at present used on the farm for conserving manures, such as manure sheds, pits, cellars, etc., are money-saving equipments.

In a somewhat different direction, yet in a line where the work of the chemist is of equal if not greater importance than in fertilizer control, is the inspection of milk. Milk is the most essential article of food for human consumption, for, properly used, it is as nearly a perfect food as is known. But milk is a fluid, and as such is easily adulterated. It consists of from eighty-five to eighty-eight per cent water, and twelve to fifteen per cent solid substance—as fat, casein (cheesy matter), albumen, sugar, and ash. On the percentage and purity of solids in milk is its quality mainly dependent. After the selling of milk became a recognized industry, adulteration came more or less to be practiced. The pump was brought into requisition. Flour, chalk, and other ingredients were used to thicken it. In 1872 Dr. C. F. Chandler, of Columbia College, stated † that, from long-continued investigation, the milk supply of New York and Boston receives on an average one quart of water to every three quarts of pure milk before reaching consumers. He further says, "With the addition of water in the proportion of one to three before delivering to consumers, we find milk-growers deprived of a business which would return to them $1,390,000 yearly, at an average first price of fifteen cents per gallon, city consumers, on the other hand, paying more than $3,700,000 annually for water."

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* Cornell University Agricultural Experiment Station, Bulletin 13, December, 1889.

† Report of the Commissioner of Agriculture for 1872, p. 335.

Here the dairy farmer was either injuring his own interests or some other fellow was hurting it. The intelligent producer realizes that anything that is done to injure the character of market milk injures the general trade. Were pure milk always placed on the market, a better price could be secured for it, and there would not be the extensive sale for patent baby foods and condensed milk that there now is. To remedy this evil it became necessary to treat milk in a measure as the fertilizers were treated, or, in other words, determine the character of milk by analysis. As in fertilizer control, so in milk inspection, Massachusetts was a pioneer worker. The first act to punish fraud in the sale of adulterated milk in Massachusetts was passed by the Legislature in 1856. This law was ineffective, so in 1859 a new law was enacted, which provided for the appointment of milk inspectors in towns and cities, whose duties it should be to detect adulteration of milk, and secure the conviction and punishment of offenders. This law has since been frequently amended and improved. At the present time the Massachusetts law requires all milk to contain at least thirteen per cent solids, and milk containing less than that amount is condemned. Since the Massachusetts law was first enacted the more progressive dairy States of the Union have passed laws to prevent deception in the sale of dairy products, and usually twelve per cent of solids is required in the milk sold in the market. The London (England) milk supply is carefully watched by inspectors. The Aylesbury Dairy Company of London is the largest of its kind in the world. During 1891 chemists analyzed 21,855 samples of the milk of this company, and found before delivery 12·75, during delivery 12·74, and after delivery 12·81 per cent solids, showing a very good grade of milk.*

That substance which makes milk most palatable is the fat in it. Good milk should have four or five; cream, eighteen to twenty-five, and butter, eighty to eighty-five per cent of fat. Skim milk, or thin, insipid, disagreeable milk, contains a small amount of milk fat. When we speak of rich milk, we mean that which contains a large percentage of this substance. There are in the United States many thousands of cows, each of which does not produce over one fourth or one half the amount of butter it should. The claim is made † that the average yield of our dairy cows is not over one hundred and twenty-five pounds of butter a year, whereas it should be three hundred pounds at the least. Some cows produce a much larger percentage of fat or butter in their milk than do others. The farmer should own the better

* Milch Zeitung, xxi, Nos. 11 and 12.

† The Dairy Industry, by Peter Collier, New York, 1889, p. 8.

class of the two, the butter dairyman can only afford to keep profitable cows, and the thousands of creameries over the country can not afford to purchase good and poor milk for one and the same price, for that is unjust to the person supplying the best grade of milk. Consequently, for some years chemists have been laboring to invent some simple method of determining the percentage of fat in milk, so that creamery men and farmers with a common education might be able to use it, and thus test their milk accurately. The first method for practical application among farmers to attract very general attention was that devised by Mr. F. G. Short, chemist to the Wisconsin Experiment Station, whose method was published in 1888.* This, however, was somewhat complex, and too slow of operation. Other methods were afterward developed by Messrs. Patrick, Parsons, Cochran, Babcock, etc. Dr. S. M. Babcock, while chemist at the New York State Experiment Station, did much valuable work in the study of milk and its products, and in 1889, after becoming chemist of the State Experiment Station at Madison, Wis., he developed and brought out a method for testing the fat in milk or cream that is now a recognized success. The method is simple, and can easily be performed by any person of fair intelligence. Equal quantities of milk and sulphuric acid are placed in specially constructed bottles, and these put in a simple machine, largely consisting of a tin cylinder or wheel, about fifteen or twenty inches in diameter, revolving on its side, within which, after the manner of spokes, are cups or pockets, in which these bottles are placed. The wheel is revolved by a crank and cog movement, and by centrifugal force and the action of the acid the fat in the milk is separated from the rest of the fluid. Enough hot water is added to each bottle to fill the measuring neck, and the fat, after five or six minutes' turning of the machine, comes to the top clear and yellow, after which the amount present may be read upon the graduated lines on the sides of the long neck of the bottle. The milk of as many as twenty-four cows can be tested in an hour. Machines of from four to fifty bottles capacity are manufactured.

This invention, the result of long and laborious scientific research, is not patented, and is largely used in the creameries of Wisconsin, Iowa, Illinois, and many other States in the purchasing of milk. The patrons of the creameries are paid for their milk according to its quality, as decided by the Babcock machine. Such a method as this is a blessing to the country, for it informs the farmer if his milk is inferior to that of his neighbor, and will consequently incite him to improve his stock.

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* University of Wisconsin Agricultural Experiment Station, Bulletin No. 16, July, 1888. A New Method for determining Fat in Milk.

The Babcock milk-testing machine is now just as generally sold by dairy firms as is an improved churn or butter-worker.

One of the most wonderful of agricultural inventions is the centrifugal or milk separator. Briefly, this machine is designed to separate the cream from the milk as soon as drawn from the cow, thus dispensing with the old process of setting milk and waiting for the cream to rise by gravity. At the International Dairy Show at Hamburg, in 1877, an instrument was exhibited* consisting of two wheels in a stand, one of which actuated the other by means of a belt. In the upper wheel four glass tubes containing milk were securely placed, and the lower wheel was then revolved, giving the upper upward of one thousand revolutions per minute. Whirling at this speed brought centrifugal force to bear on the milk in the tubes, and the cream, being lightest, collected at one end and the skim milk at the other.†

In 1879 De Laval, a Swede, exhibited to the British public at Kilburn a centrifugal separator entirely unlike the preceding one, and this machine of De Laval, in principle and general plan, is the form now commonly used over Europe and America. Milk, warm from the cow, is conveyed into a hollow steel drum about ten inches in diameter, which is made to revolve six thousand to seven thousand times per minute within a slightly larger metal chamber. The skim milk, being heavier, is thrown to the outside, and passes off through a tube which rises from a point in the skim milk where the least amount of fat exists to the upper edge of the drum; while the lighter cream rises near the center of the drum and passes off through another hole, coming out of the separator on the opposite side from the skim milk. One or two thousand pounds of milk an hour may be creamed with this machine, when run by horse or steam power. Several other designs of centrifugals have more recently been invented, some of greater capacity than the De Laval, but at the present day the modern De Laval's is unsurpassed. For small dairies De Laval invented a hand separator, which is known as "the baby separator." With the No. 2 size one person can separate the cream from three hundred pounds of milk in an hour, the drum making six thousand revolutions per minute to forty-two turns of the crank.

The manufacture of this cream separator has been followed by the invention and introduction within the past two years of a combined cream separator and butter extractor, which makes it

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* Sheldon, Dairy Farming, p. 303.

† An editorial in Farm and Fireside, for June 1, 1892, states that the cream separator has been in process of evolution for thirty-three years, and that the first known application of centrifugal force for creaming milk was made in 1859. Dairy authorities, so far as I can learn, give no data on the subject preceding that quoted above in the text.—C. S. P.

practicable to run milk into the machine and take from it butter, thus avoiding the handling of the cream at all.

The cream separator enables the dairyman to dispense with numerous utensils ordinarily used in setting milk, and in hot climates is invaluable, as it saves much of the great expense of ice. Centrifugal cream is unexcelled. In a comparatively few years these valuable dairy utensils will be commonly found in use on the dairy farms of the country.

Never before in the history of man have agricultural plants apparently suffered so greatly from parasitic vegetable growths and injurious insects. The conditions of growth have been made so much more intense for many plants that they have in consequence, in certain directions, thus made themselves more vulnerable to the attacks of parasites and insects. Some insects have been deprived of their normal food in a large degree, and have sought sustenance in agricultural crops. The destruction of these ravagers meant the saving of valuable crops; consequently much important experimental work has been accomplished with fungicides and insecticides.

For two score of years the grape rot has caused immense damage in the vineyards of the Eastern United States. A small plant, so minute as to require a high-power microscope to bring it to view, feeds upon the juices of the tender leaves and berries of the grape, blasting and ruining the fruit. The parasite matures and ripens its spores or seeds in vast quantities, and these are blown over adjacent vines and the disease more widely scattered.

Within a few years the botanists of both Europe and America began to devise means to prevent this malady. After long experimental work with fungicides and spraying machines, a mixture of sulphate of copper (six pounds), unslaked lime (four pounds), and water (forty-five gallons), termed Bordeaux mixture, was adopted,* which, when sprayed on the vines several times during the growing season before the grapes became ripe, completely prevented the ravages of the rot. Applications are made after the buds have started, and four or five times later on. Experiments, generally conducted by scientists with the Bordeaux mixture, have shown it to be most excellent for preventing numerous diseases of plants caused by parasitic growth. The method is cheap, and small hand machines, or large pump tanks with spraying attachments and drawn by teams, are made, by which one can rapidly and effectively spray large areas at comparatively slight expense. So extensive is the use of Bordeaux mixture becoming that all along the Hudson and in other grape regions, in

* American Gardening, April, 1892, p. 260.

vineyards of the country, this is the method employed to save the crop from black rot, mildew, etc.

In the cereal-growing regions, oats and wheat are frequently damaged by the ravages of smut, a disease nearly all farmers are familiar with, which destroys the seed or the entire head. This smut is a mass of spores or seeds of a parasitic plant ripened in the seed grain. The spores are scattered over the field, and mingle among the grain when thrashed out. The grain is planted in the fall or spring, and the spores of the parasite germinate and grow along with the young plant, feeding on its juices. When the head of the plant begins to mature its seed it is blasted by the smut.

A simple remedy has been devised to combat the smut of oats and what is known as "bunt" or stinking smut of wheat. Investigations begun by Prof. Jensen, a Danish scientist, and also conducted at the Kansas and Purdue University Experiment Stations, conclusively show that by soaking the seeds of these cereals in water at a temperature of 135° to 140° Fahr. for five minutes all the spores were killed, and the crop from the treated seed would grow free of the malady. This simple method, costing nothing for materials, bids fair to be extensively used in future. It is estimated, as a result of investigation, that ten per cent of the oat crop is destroyed by smut. In 1889 the oat crop of Indiana amounted to 28,710,935 bushels. The value of the estimated ten per cent of loss is $797,526 for 3,190,104 bushels of oats at 25 cents a bushel. Certainly, if this sum can be saved it should be.

Few people realize the enormous loss to agriculture through the ravages of insects. In his annual address before the Association of Economic Entomologists at Washington in August, 1891, Mr. James Fletcher, the president, gave important facts concerning the extent of the losses from insect ravages. In 1864, Dr. Shimer estimated the loss to the corn and grain crops of Illinois to be $73,000,000. In 1874, Dr. Riley estimated a loss to Missouri by insects of $19,000,000. In 1887, Prof. Osborne, of the Iowa Agricultural College, estimated the loss to Iowa by insects at $25,000,000. Mr. L. O. Howard, in 1887, estimates $60,000,000 losses from chinch bug in nine States; and Prof. Comstock estimates that the cotton *Aletia* in 1879 caused a loss of $30,000,000 in the cotton States. Finally, Mr. Fletcher estimates $380,000,000 as the sum total per year for losses from insect ravages.

There are numerous illustrations available to demonstrate how great are the services of scientific research, from an entomological point of view, to agriculture, but I will refer to only three, as these are of striking interest and serve to illustrate the work.

The citrus industry of California is a great one, involving

hundreds of thousands of dollars. What is known as the fluted scale insect had for about twenty-five years a foothold in the orange and lemon groves, and bade fair to cause enormous losses to the orchardists. A study was made of the parasites affecting this scale insect, and in 1888 the United States Government sent two entomologists to Australia to study the parasites of the scale insects in that country, and bring live specimens to California to distribute in the orange and lemon groves. Suffice it to say that these parasites rapidly multiplied and fed upon both the white and fluted scale, to their destruction. With surprising rapidity the beneficial insect destroyed the injurious one. Says Dr. C. V. Riley, United States Entomologist,* "The history of the introduction of this pest (scale insect), its spread for upward of twenty years, and the discouragement which resulted, the numerous experiments which were made to overcome the insect, and its final reduction to unimportant numbers by means of an apparently insignificant little beetle imported for the purpose from Australia, will always remain one of the most interesting stories in the records of practical entomology."

I have just quoted Mr. Howard's statement that the chinch bug in 1887 caused $60,000,000 of losses in nine States. A few years ago the attention of entomologists was drawn to the fact that chinch bugs occasionally died in large numbers from a peculiar disease. The bugs were found on the ground dead and covered with a white fungus. This disease seemed to be infectious, and several entomologists gave special attention to the matter. Prof. F. H. Snow, of the University of Kansas, pushed the investigation and thought it possible to artificially induce the disease and communicate it to healthy bugs, and thus diminish their numbers, and for the past three years Prof. Snow has worked upon this line. The Legislature of Kansas appropriated $3,500 for carrying on his investigations during 1891–'92.

In his annual report to the Governor of Kansas, describing his investigations, Prof. Snow gives a list of 1,400 persons who conducted experiments under his direction in 1891, to assist in disseminating the disease. Of these 1,071 were successful, 181 unsuccessful, and 148 doubtful, in their attempts. As a result of their season's work, Prof. Snow estimates that, on the basis of the reports rendered, $200,000 in crops were saved to those 1,071 persons who worked under his instruction.† Four hundred and eighty-two farmers reported to him an estimated saving of $87,244.10 through scattering the diseased insects among the healthy, thus

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* United States Department of Agriculture Report, 1889, pp. 334, 335.

† University of Kansas Experiment Station, First Annual Report of the Director, for the Year 1891, p. 171.

resulting in the rapid destruction of all. While this is experimental work, and may not invariably give the satisfactory results to be wished for, it illustrates in a striking manner one way in which science is working in the interests of agriculture.

In 1887 what is known as the gypsy moth (*Ocneria dispar*) was discovered in eastern Massachusetts. This insect was originally brought to Massachusetts from France, where it is exceedingly destructive to vegetation, and especially the foliage of trees. When first found in Massachusetts its character was not known by the finder, but when later examined by Prof. Fernald, of the State Agricultural College, he, knowing its nature, at once began an investigation to ascertain how much of a foothold it had in the State. It was located in numerous towns. The Legislature was advised of the dangerous character of the insect. A State law was enacted to provide against the depredations of the gypsy moth. Several commissioners were appointed and money appropriated to eradicate the insect. During the entire growing season of 1892 bands of men were engaged in destroying this insect in its various forms, and every effort is being made to prevent its further increase.

Perhaps the most serviceable labor given by science to the cultivator, in its application to insects, is the invention and perfection of insecticides. A great number of experiments have been conducted in agricultural colleges and experiment stations over the country with solutions and powders with which to kill injurious insects. Arsenic in different preparations, carbolized plaster, kerosene, hellebore, pyrethrum, hot water, and Bordeaux mixture have been in use and tested in many ways, so that, as a result of this work, standard insecticides can be recommended to farmers generally, which may be easily made at home out of simple ingredients. What is termed the kerosene emulsion is perhaps, all things considered, the best general insecticide in use. This may be made as follows, following Cook's directions:* Dissolve in two quarts of water one quart of soft soap or one fourth pound of hard soap, by heating to boiling; then add one pint of kerosene oil, and stir violently for from three to five minutes. This can then be diluted with twice its bulk of water for use. This emulsion will destroy lice on both live stock and plants.

Finally, we have in the United States nearly fifty experiment stations where trained men are working in the interests of agriculture—men whose one aim is to conduct research of benefit to mankind. Considering this fact, and that numerous scientists outside of the stations are also engaged in a class of work that of

* Michigan Agricultural Experiment Station, Bulletin 76, October, 1891, p. 5. Kerosene emulsion.

necessity is of value to agriculture, farmers should feel satisfied that their interests are being well looked after outside the pale of politics. It requires no effort to emphatically show that already many, many millions of dollars have been gained to agriculture through the disinterested efforts of scientists. Scientific investigation will continue in the future as it has in the past, and it is fair to assume that each year will see much good work done. Certainly no other class of labor is receiving greater benefits from science than is agriculture at the present day.

DIETARY FOR THE SICK.

By Sir DYCE DUCKWORTH, M.D., LL.D.,
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HON. PHYSICIAN TO H.R.H. THE PRINCE OF WALES.

IN the practice of medicine as now carried on, one marked feature is the particular and detailed attention directed to the diet. It thus happens that as much heed is paid to "kitchen physic" as to pharmaceutical agents. Dietetics, according to modern enlightenment, has secured careful study, more particularly within the last quarter of this century, and the subject was certainly insufficiently appreciated before that time. Now, guided by the researches of the physiologist and the chemist, we have more exact knowledge to bring to bear in the dietetic treatment of many morbid states, and a good deal of this knowledge is now well established and beyond dispute.

The duty of the practical physician is to apply this knowledge and to test it in his efforts to re-establish health. And here, as in the case of the employment of drugs, we have to consider the *clinical* side of the question, apart from the researches of the physiologist and the chemist in their laboratories. The progress of our art depends on the steady work of both sets of investigators. The ultimate appeal is to the clinical results. In the matter of diet we meet with strange differences of opinion—differences relating to the employment and value of sometimes very simple forms of aliment. Some of these plainly arise from ignorance in respect of the properties and qualities of certain foods. Some of them result from the foisting of mere personal or of very limited experience of such articles on patients; and some of them can only be described as mere vagaries and "fads."

The whole subject has naturally a large interest for several classes of patients, notably among the well-to-do, the luxurious, the hypochondriacal, and the dyspeptic. Such persons having exhausted many methods of drug treatment, resorted to spas,

undergone massage with incarceration, and found temporary salvation in sipping hot water, pass from one consultant to another seeking the last new paradox in dietetics. They will continue to do so, and the more if they fall into the hands of those who give them really judicious advice. They dislike that, and it is indeed seldom helpful to such persons. In this brief communication I shall have nothing to say in respect of them.

We may fairly remark that we are in danger of being perplexed by the number of patent and proprietary articles of food daily brought under our notice. The chemists, especially the Continental and American, try to help us in our daily work by contriving the most subtle, and often palatable, preparations of nutrient materials. And, not content with this, they would fain abolish almost the entire *Pharmacopœia*, and offer food and physic in one; aiding themselves in this bold effort by the most fantastic and obtrusive advertisements, which pass one's best ingenuity to escape from. Strange to say, they compel attention from persons who should know better, and should use calm judgment in sweeping most of them aside. So it happens that one frequently finds many of these vaunted preparations in use by persons who have not even a bare knowledge of their qualities and powers for good or evil.

The mischief of all this in respect of foods and new drugs is, as I have before now stated, that the practitioners in trying, as they think, to keep pace with the times, lose their hold of well-approved methods and therapeutic agents, which drop out to make way for something new and unapproved. They thus fail in the *art* of medicine, which I make bold to say is less well established to-day than it was, in many respects, half a century ago, and chiefly because of this pursuit of novelties.

We have witnessed many changes of opinion respecting some of the commonest articles of diet for the sick. The old view, that calves'-feet jelly was of exceeding nutritive value, was at one time so controverted that the jelly ceased to be much used. It is now sanctioned as having a place in dietetics, and I believe it may be safely regarded as a temporary form of nourishment of no inconsiderable value.

Beef-tea has been in and out of repute, but we have, or should have, no doubt now as to its stimulant and reparative properties. We can not think lightly of it as commonly prepared, for it can certainly prove harmful, when not desirable, as in the case of rheumatic fever. I believe it is right to withhold it in such cases. Again, it is so far apt to act as an aperient that it is best not to employ it in enteric fever, or in diarrhœa, when the bowels are in an irritable condition. Mutton, veal, or chicken essences can, however, be used, having no such aperient action. We have to

distinguish between a dietary suitable for acute disease, when we have to wait and tide over difficulties, and one that may be better adapted to restore a convalescent or weakly patient. The highest nutritive value may not be (I think it is not) the most essential point to have regard to in selecting a dietary in acute diseases.*

In most cases of acute disease, beef tea, freshly prepared, can well be taken and digested. It is now often peptonized, and I believe for clinical purposes this is generally unnecessary, unless there is manifest failure of secretion of gastric juice. This remark applies equally to milk, which is also too often given peptonized. I feel sure that we do best to administer nutriment in the most natural and unaltered forms when possible—that is, with as little of culinary or medicinal interference as may be; to give it, in fact, fresh from Nature's laboratory.

In many illnesses it is well to vary the broths given, changing from beef to mutton, veal, or chicken, and so providing variety for the patient. Milk and veal broth may often be given together. Alcoholized liquids are best not administered with animal broths. These are better given separately, but brandy, rum, or whisky may be given with milk.

It is, unfortunately, a good rule to boil milk before using it, especially in the case of children and young persons. This no doubt averts many of the evils of milk diet, and may also prevent some specific diseases. I say *unfortunately*, because I suspect boiling much damages the nutritive value of a secretion such as milk. Dilution with barley water, lime water, or the addition of sodium bicarbonate, certainly aids its digestibility in children and adults, both in health and disease; the bicarbonate being preferable if there is constipation. Whey is of considerable value for many dyspeptics, and also in enteritis, typhlitis, and intestinal obstruction, and may be freely given. Isinglass boiled in milk is very useful, and children readily take this in the form of *blanc-mange* when not too firm in consistence. Alum whey is of much avail in diarrhœa, and in cases of enteric fever with hæmorrhage. One drachm of powdered alum is added to a pint of hot milk, and the whey strained off. Cream with an equal volume of hot water can often be taken when milk disagrees.

Koumiss has considerable value in cases of great irritability of the gastric mucous surface. Koumiss one week old I find the most useful, and I have often known troublesome vomiting checked by it. Few plans are better than that of employing milk with one

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* Thus alcohol, which is by some denied to have any nutrient property whatever, will, with water, maintain life for days in some cases of acute illness, to the exclusion of any other articles of diet. I consider alcoholized liquids as *food*, for both ordinary and clinical purposes

third of its volume of lime water, given in teaspoonful doses each quarter of an hour by the clock, in rebellious vomiting of reflex origin. This quantity will be retained when larger ones will be rapidly rejected.

The inability to digest amylaceous food when pyrexia is present is generally recognized: hence the principle of milk and beef-tea diet in fever. I would strongly urge the employment of occasional draughts of pure water in fever. This is much neglected. Patients are plied with strong essence of beef, Brand's jelly, and milk with stimulants—all this *ad nauseam*, but a cooling draught of water is withheld. Water, however, is generally relished, and is of real service. It promotes appetite for the next food, and cleans the mouth.

The nutritive value of purely amylaceous foods has been decried, but, I think, with no satisfactory clinical reason. Arrowroot prepared with water only, or with milk, is certainly sufficiently sustaining for many invalids who temporarily can not take bread. In gastric and gastro-enteric catarrh it is of much service, and diarrhœa may sometimes be checked by stirring into a cupful of milk-arrowroot half a teaspoonful of raw arrowroot powder, and ten grains of powdered cinnamon.

Eggs often disagree because of their albuminous constituents. The yolk alone can often be taken with advantage in soup or in milk, or beaten up with spirit.

In the treatment of febrile states, tea and coffee are too often omitted, without reason, from the dietary. They will enable cases to go on well with a diminished amount of alcohol. Cold tea with cream is an excellent refreshment early in the morning after profuse sweats in phthisis. One meets with patients who have been forbidden butcher's meat, but allowed to eat chicken or game. I am at a loss to understand the reason for this. I recognize the greater digestibility of the latter as a rule, although I much doubt if there is really any difference if the beef or mutton be tender and of good quality. If, as I conceive, there is an idea that the one tends to plethora and vascular tension, or is apt to induce uric-acid disturbances, while the other does not, I should be prepared to controvert that idea, believing that all these flesh foods fall into the same category. With fish the case is different, and large meat-eaters may sometimes with advantage be ordered to substitute fish. It is hardly possible for any one to overeat himself on fish, and, whatever may be the explanation of the fact, I am satisfied that great mental energy and capacity may be secured by occasional meals of white fish to the exclusion of other animal food.

It were well if greater heed were paid to the treatment of the patient than is commonly bestowed on that of the disease. One not rarely finds measures adopted for the latter, and no thought

bestowed on the subject of it. It is always necessary to treat the patient, and sometimes what is seemingly necessary for his ailment is very poor treatment for him, if too long kept up. We especially note this in respect of the employment of wine and stimulants, and in the conduct of cases of Bright's disease and of chronic gout.

I think well of the skim-milk treatment in cases of chronic tubal nephritis. But it is not always well borne by the patient. He may fail to be sufficiently nourished by it, and a time comes when the diet must be altered. There is a large variety of foods available in this condition: bread, biscuit, butter, light farinaceous pudding, sometimes with egg in it, potatoes, spinach and other green vegetables, with cooked fruit. The albuminuria is often not materially increased in chronic cases if fish be given once a day, or the yolks of two eggs be added to the diet. Fat bacon may also be taken. And on alternate days we may sometimes give a little mutton or chicken, without any apparent harm to the disease, and with material benefit to the patient. The condition of the urine must be carefully noted in making these amendments. Certainly, in some cases, the "large white kidney" is an expression of a frail and feeble constitution, and has not always the same significance. A better level of general nutrition, directed in relation to the renal adequacy, may much aid in helping the kidneys to recovery. It is surely wrong to starve the patient while aiming only to rid him of his ailment. Of course, age, habits, constitution, and tissue-proclivity must be had regard to in all such cases.

The treatment of acute phases of dysentery by absolute milk diet I believe to be excellent; and I agree with those Indian authorities who forbid the least addition of animal broth or of farinaceous matters to it, possibly for many consecutive weeks.

In many cases of gout and gouty habit of body I often find inadequate diet prescribed, and a frail, painful condition of body as the result. In such cases, again, each person is to be studied as to his previous habits, inherited proclivities, and textural condition. The prohibition of meat and wine is often bad, and gouty manifestations will be held in check, not seldom, by a good diet and the use of some trustworthy wine. The tendency now is to make all gouty persons avoid meat, and drink whisky in routine fashion, or to take to water-drinking. The latter plan has its place, but many sufferers from gout, in both sexes, are better with some wine. If they starve themselves of what they formerly took, perhaps in moderation, and of what their progenitors took perhaps too freely, they will not so much have gout as gout will have them—as has been quaintly remarked. Such persons must attain their highest level of good health, and live above their

gout, or they will never be free from untoward symptoms, and will become miserable. Water-drinking at this stage of our social evolution is not, I feel very sure, the *summum bonum* for humanity.

The tendency to drink whisky, now so common, is not all due to medical prescription, as is often alleged. If good wines were readily procurable at fair prices, especially at hotels, more would be drunk. People resort to whisky because they know it is commonly to be depended on, whereas wine is dear and bad, and they seek at once to relieve their digestion and save their purses. They take far more alcohol, and lose the wholesomeness of the many other good things to be found in a moderate use of honest and sound wine. "Cheap claret" has done no good in England, but much harm, and intelligent persons now hardly know the difference between a vintage of the Médoc and the abominable stuffs that issue from Bordeaux, gathered from all other wine-growing countries, and called "claret." This has been well termed "red ink at a shilling, or, it may be, six shillings, a bottle." These compounds are disastrous to digestion, and it is small wonder that invalids and others resort to whisky. Real Médoc wine is never advertised for sale, but consumers have now ready means of knowing where to procure it.

The present agitations in favor of temperance, which should rather be termed efforts to abolish all alcoholic drinks, have, I believe, led members of our profession to neglect this important part of the subject of dietetics, and prevented their gaining an adequate knowledge of the nature and qualities of wine, a knowledge every physician should possess. Were this more commonly in possession, we should not hear such discrepant statements respecting wines dogmatically laid down by members of our profession.

Perhaps I should offer an apology for many of the remarks I have ventured to make in this communication, both because I have set down little that is new, and may also have appeared to uproot some well-grown opinions. I will only add, however, that I believe I have stated nothing that will not be found to be true and helpful in the daily practice of our art.—*The Practitioner.*

A NOVELTY in scientific photography is the photograph of a meteor, which was obtained by Mr. John E. Lewis, of Ansonia, Conn., while trying to photograph Holmes's comet. The path of the meteor is shown as a bright, clear-cut, almost straight diagonal line running across the plate, and reaching across about eighteen degrees of the heavens. Where the line enters the field it shows minute variations indicating irregularities in the amount of the meteor's light; the rest of the line is sharp and level, and of about the breadth of a lead-pencil mark. At every point it appears brighter after only an instantaneous exposure than any of the stars, which were subjected to an exposure of thirty-three minutes.

SKETCH OF SAMUEL WILLIAM JOHNSON.

PROF. SAMUEL WILLIAM JOHNSON is eminent for the services which he has rendered to scientific agriculture as an experimenter, a contributor to its literature, and a teacher; and for his agency, always active and earnest, in securing the introduction of whatever could advance its standards or add to the prosperity of the farming interest. A descendant of Robert Johnson, one of the founders of the town of New Haven, he was born in Kingsboro, Fulton County, New York, July 3, 1830. When he was four years old the family removed to Deer River, Lewis County, in the "Black River country." He was taught in the common school and in Lowville Academy, where he studied Latin, Greek, French, algebra, physics, botany, and chemistry. His home, says the American Agriculturist, was upon a large, productive, and well-managed farm, where he became familiar with a wide range of agricultural practice. He taught in the common schools during the winters of 1846–'47 and 1847–'48, and during 1848–'49 was teacher of natural science in the Flushing Institute, Long Island. In 1850 he entered the Yale Scientific School, where he spent eighteen months under Profs. John P. Norton and B. Silliman, Jr., studying agricultural chemistry. He served during the winter of 1851–52 as instructor in the natural sciences in the New York State Normal School at Albany. Having spent the succeeding winter in work in the laboratory at New Haven, he went to Germany in January, 1853, where he spent two years in study at Leipsic and Munich, under Erdmann, Liebig, von Kobell, and Pettenkofer. Thence he went to England, visiting the Paris Exposition on the way, and spent the summer of 1855 in study under Frankland.

In September, 1855, he became Chief Assistant in Chemistry in the Scientific School of Yale College, and took charge of the laboratory. The next year he was appointed Professor of Analytical Chemistry in that school, and in 1857 he took charge also, succeeding Prof. John A. Porter, of the chair of Agricultural Chemistry. In 1875 he became Professor of Theoretical and Agricultural Chemistry; and, in addition to the performance of these several duties, he has taught organic chemistry since 1870.

With the establishment of the State Board of Agriculture of Connecticut in 1866, Prof. Johnson was constituted one of its members. On expiration of his term of service, two years afterward, he was appointed chemist to the board, and has served in that capacity ever since. He began to advocate the establishment of a State Agricultural Experiment Station as early as 1873. The act of the Legislature organizing the station was passed in

1877, and, on its going into effect, Prof. Johnson was appointed director. "For many years," says the Rural New-Yorker, "the station was confined to two small rooms, and the appliances and works of reference were for the most part loaned from Yale College or borrowed from the professor's private laboratory and library."

Mr. Johnson began his literary work while still a student, writing for the agricultural papers. Among the earliest of his publications of general interest was an address before the State Agricultural Society of Connecticut, in 1866, on Fraud in Chemical Fertilizers. This was followed by the adoption of measures intended to protect buyers of fertilizers against imposition through adulterations. As chemist to the State Agricultural Society he made a series of reports on fertilizers in 1857, 1858, and 1859, by means of which knowledge on the subject was extended, and frauds received a further check. Besides his official reports, "which have been models for works of their kind," Prof. Johnson's writings include many contributions to the agricultural press, which have been highly appreciated, and several books on the special subjects of his studies. The best known of these are How Crops Grow; How Crops Feed; Peat and its Uses as Fertilizer and Fuel. The earliest and best known of these books—How Crops Grow, published in 1868—embodied the results of stvdies undertaken by the author in preparing instruction in agricultural science. Together with its companion volume—How Crops Feed—it was intended to present concisely but fully the state of the science at the time regarding the nutrition of the higher plants, and the relations of the atmosphere, water, and soil to agricultural vegetation. In it the chemical composition of agricultural plants was described in detail, the substances indispensable to their growth were indicated, and an account was given of the apparatus and processes by which the plant takes up its food. The book was received with great favor in America and in Europe. It was republished in England under the joint editorship of Profs. Church and Dyer, of the Royal Agricultural College at Cirencester; a translation of it was published in Germany under the instigation of Prof. Liebig; and other versions of it have been made in Swedish, Italian, and Japanese, and twice in Russian.

In view of the great advance that had been made in all branches of science, a new edition of How Crops Grow was issued in 1890, in which the purpose was guarded of bringing the treatise up to date as fully as possible without greatly enlarging its bulk or changing its essential character.

The account of the sources of the food of plants, which were noticed in this volume in only the briefest manner, was reserved

for the next book, its complement, How Plants Feed, published in 1870. It was exclusively occupied with the subject of vegetable nutrition. The writer, the author said, did not flatter himself that he had produced a popular book. "He has not sought to excite the imagination with high-wrought pictures of overflowing fertility as the immediate result of scientific discussion or experiment; nor has he attempted to make a show of revolutionizing his subject by bold or striking speculations. His office has been to digest the cumbrous mass of evidence in which the truths of vegetable nutrition lie buried out of the reach of the ordinary inquirer, and to set them forth in proper order and in plain dress for their legitimate and sober uses." The author's method was to bring forth all accessible facts, to present their evidence on the topic under discussion, and dispassionately to record their verdict. The books were therefore commended to students of agriculture on the farm or in the school. Besides these books, Prof. Johnson edited Fresenius's Quantitative Analysis, and two editions of his Qualitative Analysis.

The American Agriculturist names Prof. Johnson as one of the trio, consisting of Johnson, Gössman, and the late Dr. Cook, of New Jersey, "who have done so much for agricultural science and experimentation."

The purposes and efforts of Prof. Johnson to make the Connecticut Agricultural Experiment Station of practical benefit to farmers are obvious to every one who inquires into the character of the work done there, or who will peruse a series of the reports of the institution. These reports are consistently animated by the single thought of those particular features of agricultural science in which the farmers are most immediately interested. One of the predominant crops of the State is grass; the thing the farmers most need to make their agriculture profitable is economical and efficient fertilizers. Accordingly, we find these among the subjects most conspicuously presented. It would be impracticable to go over all the reports seeking instances of this happy adaptation of investigations to the peculiar wants of the people whom it was the station-director's purpose to serve; but two or three from the later reports will illustrate this characteristic of his work. Attention is directed in the report for 1886 to the important relation of the mechanical constitution of soils to the growth of plants. Very little practical benefit, the author observes, is commonly obtained from the analysis of any special soil beyond the detection of some deleterious ingredient, or proving the relative deficiency of one or more needful elements. In most of the cases where the station had undertaken to make soil analyses, the results had probably disappointed those who supplied the samples. It was pointed out as an obvious defect of the

ordinary chemical analysis that it could give at the best only an imperfect or one-sided view of the character of the soil. Two soils might agree fairly in chemical composition, and yet differ extremely in their fertility. Again, two soils might be about equally productive, and yet have unlike chemical composition. The physical characters of a soil—the texture, porosity, tenacity, amenability to tillage, retentiveness for water, capacity for heat, etc.—equally with the chemical composition, influence its productiveness and value. These considerations had been appreciated for a long time, attempts had been made to take account of the physical capacities of soils; and of late years much attention had been bestowed upon their mechanical analysis—that is, on separating into various grades, according to the dimensions of their particles. Such mechanical analysis was in most cases essential to any conclusive investigation of a soil.

In the report for 1887 the intention was declared to include in the forage garden of the station specimens of all the grasses found in Connecticut. There were about one hundred and twenty species of grasses in the State, of which eighty-one were then growing in the garden. Prominence was given to persistent meadow, pasture, and lawn grasses, and to those which continually reproduce by culture and seeding; also to other forage plants, sedges, etc. The question of methods of improving Connecticut grass lands so as to make them more productive and more permanent, wherever that was desirable, was declared a question of the first importance. To answer such questions, it is needed to know more about the plants of this character which would grow in the State with less care than others, and with no expense for seeding, their habits of growth, seed production, fitness for meadow and pasture on different soils, feeding value, rooting peculiarities, growth with other varieties, possible improvement by cultivation or by selection of seed, and the effect of different fertilizers. A more general and closer observation of the appearance and behavior of all the useful grasses was also needed, so that they might be known by botanists and farmers at sight through the spring, summer, and fall. Names were needed, also, which should be current everywhere, free from all confusion; because without names there could be no discussion of grasses away from the grasses themselves.

With this eminently practical direction and purpose of his work, Prof. Johnson is a devoted student of science, and an earnest advocate of scientific methods of investigation. He has a pleasant, modest manner, a full knowledge of human nature, and "a practical conception of what farmers want of agricultural experiment stations." As a writer, "his style is clear and concise, yet delightfully smooth, and most agreeably finished."

EDITOR'S TABLE.

SOUND WORDS ON EDUCATION.

THE article of President Eliot to which we called attention three months ago dealt with the subject of education mainly in its intellectual aspect. In a recent number of the Contemporary Review we find an article entitled The Teacher's Training of Himself, which discusses the same subject, but mainly from the moral point of view. The author is Dr. Weldon, head master of Harrow, and the article is a reproduction of an address delivered by him before the Birmingham Teachers' Association. Seldom, if ever, have we found more of sound sense and right feeling in any discussion of the general subject of education than is contained in this essay of Dr. Weldon's. From first to last it may be said to be a plea for that which, according to Dr. J. M. Rice, is so conspicuously lacking in most of our own public schools—sympathy. The writer sees that this, above all things, is needed to vivify education and make it what it ought to be, a blessing both to the giver and the receiver—to prevent it, indeed, from becoming positively injurious in its effects. Is it due simply to mental inertness and inferiority on the part of the mass of society that there is on the whole so little love of knowledge and so little pleasure in intellectual effort? May it not be in a measure due to the fact that in childhood the acquisition of knowledge was carried on under more or less repulsive conditions with the mental faculties only half aroused and the sympathetic or emotional nature wholly untouched, except in so far as it may have been moved to opposition?

It is the first step, says Dr. Weldon, in the teacher's self-culture to realize the dignity of his profession, which, though it may lack the distinction belonging to the pulpit, the platform, or the bar, has "this signal advantage, that in all its branches and among its humblest no less than its highest representatives, it aspires constantly to two objects that are among the worthiest of which human nature is capable—namely, the promotion of virtue and the increase of knowledge." He places the promotion of virtue first, but in actual practice we fear that the amount of attention given in public schools of the ordinary type, here or elsewhere, to that special object is far from commensurate with its recognized importance. The discipline of the school is often said to be of itself a powerful moral influence; and so it would be if the discipline were maintained in any large degree by the help of sympathy; but if it is enforced in the thoroughly unsympathetic way described by Dr. Rice we fear it can hardly be counted on for any very moralizing effects.

We must, however, pass over much that we would wish to note in Dr. Weldon's address, in order to leave space for a few of his more striking remarks. The following are worth quoting and remembering:

"If a teacher is to train others, still more must he train himself. . . . The reason is that the influence of every teacher depends not upon what he says, nor even upon what he does, but upon what he is. He can not be greater or better than himself. He can not teach nobly, if he is not himself noble.

"It is sadly true that we as teachers may make mistakes. We may break the bruised reed; we may quench the smoking flax. By making the young dislike us we may make them dislike the subjects we represent. Strongly would I impress upon you and upon myself the terrible responsibility which belongs to

us of making one of these little ones to offend. Perhaps if I might sum up in a single phrase the teacher's true temper toward his pupils, especially boys in a large school, I should say it is one of *sympathetic* severity. . . . Severity is not worth much if it stands alone. It may be said that severity without sympathy is a guarantee of failure.

"There is one word, and only one, that I have simply begged my colleagues never to use in their reports of boys—the word 'hopeless.' Masters and mistresses may perhaps be hopeless, I can not tell; but boys and girls—never.

"An angry schoolmaster, or rather a schoolmaster who can not control his anger, is the drunken helot of the profession. In an angry moment words are spoken, deeds are done, that are irreparable. Fling away from you the poisoned shafts of sarcasm; they are forbidden to the humanities of school life.

"It appears to be the particular danger of schoolmasters and schoolmistresses that their profession has naturally a cramping or narrowing influence upon the mind; it is therefore the primary duty of all teachers to take every opportunity of enlarging and liberalizing their views. The schoolmaster must not be a schoolmaster only; he must be more than a schoolmaster. He must be a man of wide interests and information; he must move freely in the world of affairs. Fill your pitchers, however humble they may be, at the wide and ever-flowing stream of human culture. It is my counsel, as a precaution against narrowness, that you indulge largely and lavishly in reading. You can hardly read too much. It may be a paradox to say so; but I doubt if it matters much what you read, so long as you read widely. . . . Novel-reading I conscientiously recommend. It will take you out of yourselves, and that is perhaps the best holiday that any one can have. It will give your minds an edge, an elasticity. The peril of reading no novels is much more serious than that of reading too many. . . . Apollo himself does not keep his bow on the stretch forever, and most of us need relaxation as much as Apollo."

The above is good advice, and happy is it for those who can take it to heart and act upon it—for those whose faculties have not been already so deadened by a mechanical routine as to be incapable of the ambition of individual culture. Dr. Weldon speaks and writes from the elevated standpoint of head master of one of the great English public schools, a position of as great independence probably as any the educational world affords, and one in which there is infinite scope for the exercise of individuality. The position of the average public-school teacher is very different. To the latter functionary individuality may be a personal advantage, but it may easily become, from a professional point of view, a burden and a drag through the lack of encouragement or even opportunity for its exercise. That the advice given by Dr. Weldon as to reading is not very widely followed out by teachers in this country was proved some few years ago by some one who took the trouble to write to all the principal public libraries to ascertain to what extent teachers took advantage of the privileges which these institutions afforded. We forget the precise result of the inquiry; but it showed that the teachers, as a body, used the libraries almost less than any other class of the community. We recall this fact in no unfriendly spirit, but solely with a view of showing to a public that is hard to convince on this point how far we are from having as yet commanded the most successful conditions for general education.

THE SCIENTIFIC ALLIANCE.

THE formation of the Scientific Alliance of New York marks an important step in the scientific movements of this city, and will not be without beneficial influence, we believe, in the advancement of research in the country at

large. New York, long recognized as the great financial and commercial center of the Union, and pre-eminent in some other departments of the life of the century, has not been eminent in science. It has, indeed, as President Low said at the late joint meeting of the Alliance, many scientific men of the first order, and has a record of scientific work of the highest character that has been done by such men as Draper, Morse, Rutherfurd, Newberry, and Edison; but the fame of that work has been dissipated: it has never been concentrated, as in other metropolitan cities and many much smaller towns, under the panoply of a single organization, central for all the branches of research. London has its Royal Institute and Royal Society; Paris, Berlin, and other European capitals have their Academies of Sciences, where the work of the whole nation has a common home, and contributes to the fame of its chief city. In the United States, Boston has its Academy; Philadelphia, its Academy and the American Philosophical Society; Brooklyn, the Brooklyn Institute; and other cities, down to many relatively small ones, have central organizations through which the scientific work done by citizens receives all the credit it is entitled to; but New York, which should have been in the advance of all of these, has had only a few struggling societies devoted to specialties—nothing comprehensive enough to command the allegiance of students of different branches and the attention of the public. To use President Low's words again, "These bodies have revealed at once the strength and the weakness of New York in these directions. They have made clear beyond a doubt the vast resources of the city, both in men and means. But they have also revealed the fact that these resources are as yet insufficiently organized." To this time, by reason of the division among these special societies and the want of a general one, the scientific spirit of the city has lacked intensity of expression. It will be the object of the Scientific Alliance, as President Low believes it has the capacity, to give to New York the agency which it has long needed to develop to the utmost its activities of investigation and experiment in the direction of pure science.

Seven societies, each of which is well known and has done creditable work in its special field, have united in the formation of the Scientific Alliance. They are the New York Academy of Sciences, the Torrey Botanical Club, the New York Microscopical Society, the Linnæan Society of New York, the New York Mineralogical Club, the New York Mathematical Society, and the New York Section of the American Chemical Society.

The advantages which are expected to accrue to these societies and their work from united organization were well presented in the address of Mr. Charles F. Cox. Among them are "the stimulating and re-energizing effect which will be wrought in them by the demand made upon them for an increased output of effort for the public good"; the re-enforcement and encouragement they and their members will receive from contact with one another; the saving of work in doing over again what has been already done which will be effected by bringing these laborers in different fields into co-operation and consultation with one another, and enabling them to contribute their several results to a common stock; in short, a union of forces to produce the best results.

The need of endowment for scientific research and publication was presented at the meeting for organization in an address by the Hon. Addison Brown. The existence of such a body as the Alliance, proving its efficiency by its work and extending its influence, may be expected to attract the gifts of liberal-minded capitalists, as do other enterprises for the public good that ac-

complish something. Still another advantage that may be derived from the organization is revealed in Prof. Bolton's idea of its furnishing accommodations in a single building for all the libraries of the societies and for such other libraries of scientific works as may seek a domicile there; each library to be kept distinct, but accessible alike to all the societies, and one supplementing the others. For this and other purposes of the Alliance a building will be necessary, and a plea in behalf of this was made by Prof. N. L. Britton.

Another view of the advantages that may be derived from this movement is afforded by the advances which are being made in all departments of enterprise in which scientific research is the original and most important factor. "The practical men," said the Hon. Addison Brown, basing his remark on the confession to him of an electrical expert who had made several very interesting and important inventions, "do not work at random, but upon the basis of what scientific research and publication have previously put within their grasp." Capitalists and corporations have derived immense wealth and power from the fruits of this work; and yet science, which has furnished them the instruments of their success, has received the most niggardly treatment from them, and has been spurned and scorned by them as unpractical. A society that will serve as a center for its scattered forces and give it a voice by which it can assert itself and emphasize its claim for recognition can not fail to help it greatly in commanding the homage of its debtors.

MORAL EVOLUTION.

THE recent articles of Prof. St. George Mivart on Happiness in Hell, in spite of what must seem to many their fanciful character, may reasonably be regarded as an encouraging sign of the progress the modern world is making in the direction of reasonable views and humane sentiments. Mr. Mivart states at the outset that "not a few persons have abandoned Christianity" on account of the popular doctrine of a hell involving unending torture for untold multitudes of human beings, and that this doctrine now "constitutes the very greatest difficulty for many who desire to obtain a rational religious belief and to accept the Church's teaching." The object which he has in view is to show that the absurd and cruel ideas which have gathered round the conception of hell are no essential or authoritative part of Christian doctrine. Whether he has succeeded in doing so, we must leave to the professional theologians to discuss and, if possible, decide; but, meantime, some of the writer's utterances deserve to be put on record as evidences of the moral evolution which theology itself is undergoing.

"To think," says Prof. Mivart, "that God could punish men however slightly, still less could damn them for all eternity, for anything which they had not full power to avoid, or for any act the nature or consequences of which they did not fully understand, is a doctrine so monstrous and revolting that stark atheism is plainly a preferable belief." The writer of these words could evidently not subscribe to the Westminster Confession, nor to the views of those Congregationalists who have lately been so much exercised over the daring theory advanced by some of their brethren that fairly decent heathen may perchance escape hell without any aid from missionaries. A Catholic authority whom Mr. Mivart quotes says that "if there is one thing certain it is this—that no one will ever be punished with the positive punishments of the life to come who has not with full knowledge, complete consciousness, and full consent turned his back upon Almighty God." The same authority further says that "the God

of all justice must, and will, make every allowance for antecedent passion, for blindness, for ignorance, for inadvertence"; and this, Mr. Mivart explains, will apply to that "large proportion of men's actions which can not be freely controlled by them on account of ancestral influences, early associations or intellectual and volitional feebleness." As we read these declarations we begin to find ourselves somewhat at a loss to conceive the kind of person who would really constitute an eligible candidate for the place which Mr. Mivart so far offends ears polite as to mention. However, some do get there, and then they fare according to their deserts. Their great loss consists in being shut out from what theologians describe as "the beatific vision"—that is, from the happiness of heaven; but they have apparently all the means of enjoyment and even of moral improvement open to them which they had on earth, though without hope of ever changing their fundamental state of separation from God.

Waiving all questions as to the reality of the matter which Mr. Mivart discusses, we venture to express the opinion that the view he puts forward is far more favorable to the interests of religion, and much better adapted to produce moral thoughtfulness, than the heretofore current notions, which no amount of sophistical ingenuity can torture into conformity with justice, benevolence, or reason. So far we extend to the distinguished naturalist and, as it would appear, not inexpert theologian our sympathy, and bid him God-speed.

THE Index to Volumes I to XL of The Popular Science Monthly, announced as in preparation some months ago, has been completed, and up to March 25th about fifty pages had been put in type. It will make nearly three hundred pages, and, as setting the type for such a book is slow work, we must ask a little more patience from the many who have been anxiously inquiring for the volume.

LITERARY NOTICES.

A HANDBOOK OF PATHOLOGICAL ANATOMY AND HISTOLOGY. With an Introductory Section on Post-mortem Examinations and the Methods of Preserving and Examining Diseased Tissues. By FRANCIS DELAFIELD, M. D., LL. D., and T. MITCHELL PRUDDEN, M. D. Fourth edition. New York: William Wood & Co. 1892. Pp. xvii+3 to 715.

THE fourth edition of this standard work has an increase of more than one hundred pages of text, with the addition of seventy-six engravings, while many portions of the book have been rewritten, so that it may include the principal discoveries that have been made in pathology since the publication of the third edition in 1889.

In the section on the methods of preparing pathological specimens for study there has been added a description of the phloroglucin method of decalcifying bone, which is one of the best that can be used, and there is also a description of the satisfactory method of hardening tissues by Lang's corrosive-sublimate solution.

The chapter on the composition and structure of the blood has received important additions in the description of oligocythæmia and of the determination of the presence of the micro, macro, and poikilocytes, as well as a description of the polynuclear neutrophile and eosinophile leucocytes and lymphocytes; and there is a section on the methods of examination necessary to study these various forms.

One of the most important additions to the volume is the section on hypertrophy, hyperplasia, regeneration, and metaplasia; the authors calling attention to the pathological importance of a knowledge of caryocinesis, because a recognition of mitotic figures may permit a decision regarding the particular cells involved in the formation of new tissue.

The chapter on inflammation has been practically rewritten and rearranged, the subjects of tubercular and syphilitic inflammations being now considered under the sections relating to the diseases producing them.

The chapter on animal parasites contains a reference to the *Amœba coli* and its relation to dysentery, and also brief reference to the presence of coccidia in certain epithelial growths. The chapter on vegetable parasites contains reference to ptomaines, toxins, and toxalbumins, as well as an excellent summary of the important question of immunity, though the authors do not commit themselves to any doctrine regarding that subject.

The subject of infectious diseases induced by the pyogenic bacteria has been rearranged and placed as one of the earlier chapters in the work, which seems to us to be an excellent plan. An illustration of the caution displayed by the authors is shown in the section on lupus, in which reference is made to the fact that, while that disease is a form of tubercular inflammation, it is not unlikely that in the clinical group of diseases called lupus there may be lesions that are not caused by the tubercle bacillus, a point that must be decided by more exact bacterial studies. This same caution is shown in accepting the bacillus described by Lustgarten as the cause of syphilitic inflammation.

The skepticism expressed in the former edition regarding the causative relationship of Löffler's *Bacillus diphtheriæ* to diphtheria, has been supplanted by a frank acceptance of that organism, the first sentence in the section on diphtheria defining that as an acute infectious disease caused by the *Bacillus diphtheriæ*.

New sections on rhinoscleroma, tetanus, influenza, smallpox, scarlatina, measles, and actinomycosis, and descriptions of the *Bacillus œdematis maligni*, *Bacillus pneumoniæ*, and *Bacillus coli communis* have been added.

The chapter on tumors contains a reference to the structures that have been found in and between the cells of tumors, "*inclusions*" that the authors consider to be invaginated epithelial or other cells, or cell nuclei that have undergone various degenerative metamorphoses, fragmentation, etc. They state that some of the cell inclusions in carcinoma may be coccidia or allied organisms; but while not asserting that tumors can not be caused by parasites, they do not believe that adequate ground exists for believing that they are so caused, because the transplantation of tumors from one species of animal to another has almost uniformly failed, while it has been impossible to cultivate either directly or by inoculation any constant organisms from these morbid growths. This matter is one that is attracting the attention of pathologists in several countries, and the more thorough study of the subject of the etiology of cancer will probably determine the status of the coccidia in relation thereto.

The section on chronic arteritis has been rewritten, the authors believing that the morbid changes in the arteries are the results of a combination of chronic productive inflammation and of degeneration occurring in connective tissue—a point of view that regards the arteries as definite parts of the body, and as likely to become the seat of chronic inflammation as the liver or kidneys.

The subject of colitis is another valuable addition, and the text is enriched by some excellent engravings of the several varieties of pathological conditions that occur in inflammation of the large intestine.

In the section on the organs of generation reference is made to the adenomata that lie on the border between the distinctly benign and the definitely malignant new epithelial tissue growths, attention being called to the fact that the more benign forms are extremely prone to develop, both in structure and malignancy, into carcinomata.

While the substitution of the terms "lymph nodes" and "lymph nodules" for "lymph glands" and "lymph follicles" respectively was recommended in the last edition, the change has been made throughout the text in this volume.

The work is fully abreast of the scientific knowledge of the day, and it will undoubtedly be accorded a popularity similar to what it has received in the past.

THE STORY OF COLUMBUS. By ELIZABETH EGGLESTON SEELYE. New York: D. Appleton & Co. Pp. 303. Price, $1.

THIS volume is the first of a series entitled Delights of History, and a delightful book has been made of it. Beginning with the wonderful journeys of the Polos, and the expeditions sent out by Prince Henry of Portugal, events which may well have fired the imagination of the youthful Columbus, we are brought at length to the gates of Genoa. Here we learn something of the condition of the weavers among whom

the Colombos were numbered. Even the house in which the family lived is pointed out. Then follows the story of Columbus's journey to Portugal, his weary waiting in Spain, his voyages, discoveries, misfortunes, and last days spent in pleading with the unappreciative Ferdinand. The tale is related in very simple but graphic fashion, with many touches of humor, while the varied illustrations constantly keep fresh the flavor of the time. Only those anecdotes are given that come from authentic sources, and the recent labors of Mr. Henry Harrisse and Signor Stalieno have added so largely to the fund that there are enough to make the narrative sufficiently life like. No attempt is made to screen the failings of Columbus —his pursuit of wealth, his curious theories, and the evil which is chargeable to him as an exponent of his time, the establishment of slavery in the New World. On the other hand, these are not enlarged until they obscure his courageous project and unflagging zeal. He still remains "the most conspicuous figure in the history of his age." He crossed the sea of darkness, and we rightly honor him for his great achievement.

THE VISIBLE UNIVERSE. By J. ELLARD GORE, F. R. A. S. London: Crosby Lockwood & Son. New York: Macmillan & Co. Pp. 346. Price, $3.75.

ALTHOUGH astronomers have not yet solved the problem of celestial construction, the author of this volume refrains from adding any new conjecture to the list. He examines critically all the explanations worth serious mention, and this task may well have served to keep him within the dry land of fact. Besides the theoretical discussions, the book contains the latest observations of the position of stars and nebulæ and, so far as known, their motions and chemical composition.

Five principal objections have been brought against the nebular theory; most of these have been well answered by M. Roche. According to M. Wolf, two points are yet undetermined—how large planets were formed from the nebulous mass, and how the equatorial and orbital inclinations were produced. M. Faye, however, finds the fifth objection—the retrograde motion of the satellites of Uranus and Neptune—destructive of Laplace's theory and advances another hypothesis in his work, Sur l'Origine du Monde, with which Mr. Gore agrees. In this he assumes that the earth was formed before the sun, and that its internal heat sufficed for the evaporation of water and for the uniform vegetation that existed for æons of time. Laplace did not explain the origin of the primitive nebula, therefore Dr. Croll considered the hypothesis incomplete and furnished a cause in his impact theory. Two dark bodies endowed with enormous velocity collided in space and produced a perfect nebula!

A contention which promises no settlement is the duration of the sun's heat in past time. Noted physicists allow only twelve millions of years as the maximum period on the gravitation theory. This is insufficient for the geologists, who demand a hundred millions for the denudation of rocks. Dr. Croll's careful estimate is ninety millions; while biologists ask for a still longer period for the evolution of species. Most astronomers concur in the theory of Helmholtz that the heat of the sun is caused by the shrinkage of its mass through gravitation. To this philosopher also is due the vortex-ring idea —that matter consists of whirling portions of the luminiferous ether. This wondrous fluid, supposed to fill interstellar space and act as a medium for the transmission of light, is enormously elastic and wholly unlike matter, since planetary motion is not retarded by it as it would be by the most attenuated gas.

The spectroscope, which has revealed so much of the constitution of the stars, shows also another defect in the nebular theory, unless chemists may come to the rescue. The spectra of various nebulæ give only hydrogen and one other unknown element. If the solar system was evolved from a nebulous mass by condensation, whence the dozen elements of the sun and the sixty-five of our own planet? It has been suggested that all our elements may be further resolved into one original element. In anticipation of its discovery this has been named *protyle*.

Lockyer's hypothesis was that the upper reaches of the atmosphere contained particles of magnesium, manganese, iron, and carbon, and that nebulæ were swarms of meteoritic dust. His observations in regard to

the magnesium flutings are not accepted by other astronomers, and experiments do not confirm his explanation of the aurora. Most puzzling of all astronomical problems perhaps is the arrangement of stars. If we could observe from some other point in the heavens the system might be disclosed to us, or even if we could compute the distance of every star, the design might appear. In all cases, however, the parallaxes are so small that the measurements are exceedingly difficult. The number of visible stars is estimated by the author as seventy millions. Outside of this finite universe there may exist vast systems in space whose light has not yet reached us, or which may be forever hidden, because light itself is extinguished in a separating void.

Some fine photographs of stars and nebulæ accompany the text; an index and notes are also added.

HUMAN EMBRYOLOGY. By CHARLES SEDGWICK MINOT. Illustrated. New York: William Wood & Co. 1892. Pp. xxiii +815.

THE appearance of another work on embryology justifies the assertion that was recently made in these columns that there was a growing appreciation of the importance of this subject. The present volume has been expected for some time past, as the announcement was made some years ago that Prof. Minot was engaged in the preparation of a work upon this topic. The ten years' labor that has been directed to making original investigations and to collecting and reviewing the literature of the subject, is presented in this splendid volume that is a worthy representation of American scholarship and research.

On account of the intimate relations between the uterus and the embryo, the author devotes his first chapter to a careful presentation of the anatomy and the histology of the uterus, together with a description of the changes that occur during pregnancy. In the second chapter there is a general outline of human development, in which there are retrogressive and progressive histories of the fœtus and its envelopes.

The author calls attention to the limitation of the term *genoblast* to the sexual elements proper, to the spermatozoön or the egg-cell after maturation, and not to the spermatophore or the egg-cell before maturation. The subjects of spermatozoa, ova, ovulation, and impregnation are described with reference to the latest investigations. The author believes that the ovum draws the spermatozoa toward itself by chemical influence, acting as an attracting stimulus, in a similar manner to the attraction Pfeffer has shown certain chemical substances may have for moving spores; the attractive power of the ovum being annulled or weakened by the formation of the male pronucleus. As a solution of the origin of sexuality the attractive hypothesis is offered that *sexuality is coextensive with life; that in protozoa the male and female are united in each of the conjugating cells, and impregnation is double; and, finally, that in the metazoa the male and female of the cells separate to form genoblasts or true sexual elements, and impregnation is single.*

The author presents a great deal of evidence to support the theory that concrescence is the typical means of forming the primitive streak in the vertebrate, the primitive axis of which is formed by the growing together in the axial line of the future embryo of the two halves of the ectental line.

The origin of the mesoderm, the formation of the cœlom and mesothelium, and the origin of the mesenchyma, are carefully described in connection with a review of the principal theories in regard to the morphological significance of the mesoderm, the author believing that Hatschek's germ-band theory offers the best-founded explanation of the vertebrate mesoderm.

Emphasis is laid on the fact that the splanchnocœle (pleuroperitoneal cavity) is almost, if not quite, from the start divided into a precociously enlarged cervical portion (amnio-cardial vesicles), and a rump portion (abdominal cavity), the boundary between the two portions being marked by the omphalomesaraic veins, that run from the area vasculosa into the embryo proper at nearly right angles to the embryonic axis.

The author agrees with Ziegler that the red blood-cells of all vertebrates arise by proliferation of the endothelial lining of the vessels, basing this conclusion upon the facts that in various vertebrates certain parts of the vascular system are at first solid cords of cells, the central portion becoming blood-cells

and the peripheral portion the vascular wall, and in birds the red cells arise from the walls of the venous capillaries of the bony marrow. In other words, the blood-cell is a liberated, specialized endothelial cell.

One of the most interesting and valuable chapters in the volume is that on the germinal area and the embryo and its appendages, in which there is a synopsis of the published descriptions of embryos not over three weeks old; from these it is learned that no human ovum has been observed to have a primitive streak, which is the first stage of the series formulated by the author. In this stage (twelfth or thirteenth day) the human ovum is a rounded, somewhat flattened sac of three or four millimetres in diameter, bearing an equatorial zone of short, unbranched villi that are probably formed by the ectoderm only; the wall of the sac is ectoderm, whether underlaid by somatic mesoderm or not is uncertain; a mass of cells is attached to the inner wall of the sac, over one of the bare poles of the ovum, constituting the rudiment of the embryo. The second stage is characterized by the appearance of the medullary plate, the third by the appearance of the medullary groove, the fourth by the formation of the heart and medullary canal, the fifth by the development of the first external gill-cleft, the sixth by the appearance of two external gill-clefts, the seventh by the appearance of three gill-clefts, and the eighth by the appearance of four external gill-clefts.

The fourth part of the work includes descriptions of the chorion, the amnion and proamnion, the yolk-sac, allantois, and umbilical cord, and the placenta.

The final portion of the volume is devoted to chapters on the growth and development of the various organic systems of the fœtus.

Each section and chapter aims to present a comprehensive review of the literature regarding the subject therein considered, the author stating the reasons for accepting certain theories in preference to others. One blemish in the volume is the free use of German embryological terms. The author's devotion to German has often led him to use, also, forms of expression that, while correct in German, are faulty English. This is, however, a minor and remediable fault in what is a most excellent book.

PIONEERS OF SCIENCE. By OLIVER LODGE, F. R. S. London: Macmillan & Co., 1893. Pp. 404. Price, $2.50.

THIS work consists of a course of eighteen lectures on the history and progress of astronomical research, with biographical sketches of each pioneer and an examination of their influence on the progress of thought. It is divided into two parts. The first, which is entitled From Dusk to Daylight, contains ten lectures giving a brief outline of the physical science of the ancients, with an interesting account of the progress of astronomy from Thales, 640 B. C., to the death of Newton, 1727 A. D. The second part is called A Couple of Centuries' Progress, and embraces the period of astronomical discovery from the publication of Newton's Principia to the present time.

The author shows considerable power of lucid condensation in his description of the labors of the early astronomical scientists, and while giving a brief history of their discoveries—notably those of Archimedes, Ptolemy, and Roger Bacon—he brings us at a bound over the void of the middle ages to the beginning of the sixteenth century (1543) when Copernicus (Nicolas Copernik) published his famous work, De Revolutionibus Orbium Cœlestium, in which he proved that the earth is a planet like the others, and that it revolves round the sun—thus shattering the accepted Ptolemaic system and revolutionizing all other (speculative and theological) doctrines concerning the form of the earth and the motion of the heavenly bodies.

This period is called by Mr. Lodge "the real dawn of modern science." His sketch of Tycho Brahé is most interestingly written; and in the summaries of facts which preface each lecture will be found some curious coincidences of the dates of the birth and death of the famous philosophers from Copernicus to Newton. While admitting the great labors and immense value to astronomical research of Galileo's discoveries, the author does not class him with Copernicus, Kepler, or Newton; in fact, he says that "Archimedes and Galileo can only be considered in the light of *experimental* philosophers." Lord Bacon, who flourished about the same time as Descartes, is very summarily dismissed; he does not admit him into his list of philosophers, and says: "His (Bacon's) methods are not

those which the experience of mankind has found serviceable; nor are they such as a scientific man would have thought of devising."

Mr. Lodge pays reverent tribute to the genius of Sir Isaac Newton, and claims for him the palm-wreath among all other philosophers—ancient or modern. His treatment of the biographical sketch of Newton and of his discoveries and the preparation of his laws of gravitation, motion, etc., as contained in the Principia, are most interesting as well as valuable.

The second part of the work (eight lectures) is rather condensed. Laplace's mathematical genius is briefly described, while the birth of stellar astronomy and the works of Sir William and Caroline Herschel are excellently portrayed. The volume closes with chapters upon Comets and Meteors, and Tides and Planetary Evolution. It is profusely illustrated.

HYGIENIC MEASURES IN RELATION TO INFECTIOUS DISEASES. By GEORGE H. F. NUTTALL, M. D., Ph. D. (Göttingen). New York: G. P. Putnam's Sons, 1893. Pp. 112. Price, 75 cents.

THIS is a very useful little work and should have a place in every home library. There seems to be an almost general ignorance of both the causes of infectious diseases and how to prevent their spread; and Dr. Nuttall has produced this little handbook in a form that is so simple and instructive that even the least scientific reader can, without any difficulty, prepare and use ample means for the disinfection of persons, houses, furniture, etc.—no matter from what cause the infectious material may exist.

The author warns people against using "made and patent disinfectants"; for, as he says, "the term disinfection means the *absolute destruction* of infectious material," and "many preparations sold as disinfectants are nothing of the kind," but belong to the antiseptic and deodorant classes. He gives, as the best and most certain methods, those by fire, dry heat, steam, and chemicals, and in a foot-note to the paragraph "Disinfection by Boiling," he quotes Flügge most instructively: "The ordinary treatment to which soiled linen and clothes are subjected in the laundry (one half-hour's boiling) would be quite sufficient for their disinfection were it not for the fact that the process of boiling is preceded by the processes of sorting, soaking, and *rinsing in cold water*."

The volume contains practical directions for the treatment of infectious diseases in private houses and other places; and the second part is devoted to excellent "information as to the causes and mode of spreading of certain infectious diseases and the preventive measures that should be resorted to."

REST AND PAIN. By the late JOHN HILTON, F. R. S. London and New York: George Bell & Sons. Pp. 514. Price, $2.

THIS work, which its editor speaks of as "acknowledged to be one of our few surgical classics," has reached its fifth edition in England, and is now offered to medical students and practitioners in America. Its special claim to attention is that it presents certain facts in a different grouping from that of the usual treatises, thus throwing a new light upon the bearing of much that may seem useless or abstruse to the student. It has the two objects of preaching to physicians a let-alone gospel, designed to secure greater reliance upon the work of Nature, and of pointing out how much can be learned in regard to various disorders from the pains that accompany them. The volume consists of a course of lectures delivered by the author as consulting surgeon to Guy's Hospital, under the title, The Therapeutic Influence of Rest and the Diagnostic Value of Pain in Accidents and Surgical Diseases. It deals with injuries and diseases of the brain, spinal column, the joints, the sacro-iliac region, with abscesses, and miscellaneous other disorders. A large number of cases are quoted in this treatise, and the text is illustrated with 105 cuts.

DOMESTIC SCIENCE. By JAMES E. TALMAGE. Salt Lake City: George Q. Cannon & Sons. Pp. 389.

THE field of this book embraces the applications of science to the affairs of domestic life—a field concerning which there has always been a great amount of ignorance. The dispelling of this ignorance was one of the tasks that enlisted the efforts of the founder of this magazine, who published his Handbook of Household Science over thirty

years ago. Dr. Talmage's treatise is very like the Handbook as to scope and method, and the author quotes his predecessor frequently in foot-notes. It is divided into four parts, treating respectively of Air and Ventilation with chapters on Heating and Lighting, Water, Food and its Cookery, Cleansing Agents, to the last of which is added Poisons and their Antidotes. In each of these divisions the laws of Nature that especially concern the matters in hand are stated, and the evil effects of disregarding these laws in each case are pointed out. The text is much strengthened by illustrations. The book has been adopted as a text-book for the Territory of Utah, and the present is a second and revised edition prepared for such use. The introduction of this subject into the schools can not fail to do much good.

INTRODUCTION TO PHYSIOLOGICAL PSYCHOLOGY. By Dr. THEODOR ZIEHEN. Translated by C. C. VAN LIEW and Dr. OTTO BEYER. New York: Macmillan & Co. Pp. 284. Price, $1.50.

THE recent introduction of the inductive and evolutionary mode of treatment into the field of mental science has brought forth abundant fruit where, for a long time, barren speculation had held sway. Psychology, or a division of it at least, has become a natural science, and knowledge of mental processes has been rapidly extended in consequence. Especially has this work gone on actively in Germany, and the facts obtained have received two distinct interpretations—the one held by Wundt and his school, the other by Münsterberg and Ziehen. Only one treatise on physiological psychology — the large work by Prof. Ladd, of Yale—has appeared in English, hence the translators have thought that such a small introductory compendium as the present volume would be desirable. The work originated in a series of lectures that Dr. Ziehen has delivered at the University of Jena for several years. It has been the aim of the author throughout to develop all explanations from physical or physiological data, and to account for the presence of certain functions by an application of the laws of evolution. The doctrines that he presents differ essentially from Wundt's theory and conform closely to the English psychology of association. By introducing an especial auxiliary function, the so-called apperception, for the explanation of certain psychical processes, Wundt evades numerous difficulties in demonstration. This book is intended to show that such an "auxiliary function" is superfluous, and that all psychological phenomena can be explained without it.

CHEMICAL LECTURE EXPERIMENTS. By G. S. NEWTH, F. I. C. London and New York: Longmans, Green & Co. 1892. Pp. 323. Price, $3.

THIS book is of some importance to chemical lecturers and teachers, as well as being a valuable assistance to the chemical student. It consists of six hundred and thirty-two illustrated experiments, which are given with remarkable lucidity, the author claiming that "no account of any experiment has been introduced upon the authority solely of any verbal or printed description, but every experiment has been the subject of his own personal investigation, and illustrated by woodcuts from original drawings." It is arranged in such a manner that students may learn from it the methods of preparation and most of the important properties of the non-metallic elements and their more common compounds. As a companion to the lectures which he may attend, the chemical student will find fully described in this book most, if not all, of the experiments he is likely to see performed upon the lecture table, thereby relieving him from the necessity of laboriously noting the apparatus, etc., used by the demonstrator. Many of the experiments are novel and interesting, and the tables which form the appendix will be found to contain important information for which books of reference are usually needed.

An overgrown volume of nearly fifteen hundred pages on *Education in the Industrial and Fine Arts in the United States* comes to us from the Bureau of Education. This is only the second part of a special report by *Isaac Edwards Clarke*, and the editor states that most of the matter intended for this volume has been relegated to a third part. There is first an Introduction of over a hundred pages, in which the editor devotes several of the early pages to telling how his first part has been praised. Soon after this come three

tributes to deceased educators, which would be better published elsewhere. A little farther on the editor has a tilt with Prof. C. M. Woodward, and near the end several defenses of the public schools, having no bearing on the proper subject of the report, are brought in. The report proper consists of five hundred pages of well-digested material, being mostly accounts of the instruction in industrial art and the use of mechanical tools that has been introduced in various places. This is followed by eight hundred pages of appendixes made up of miscellaneous reports, essays, and addresses, parts of which are valuable, other parts pleasant but vague, and much of the whole merely duplicating other matter in the volume. There is a great deal of matter in these appendixes that only makes the volume clumsy and impedes the earnest student of pedagogy. Here and there we find poetical quotations or wholly unnecessary lists of names, and in one place a lot of "after-dinner" speeches with the "applause" duly interjected. It is no wonder that the public printer can not get these bulky reports out until they are stale, and that so many copies go unread back to the paper-vat.

A little text-book devoted wholly to mensuration has been prepared by *Alfred J. Pearce*, and is published by Longmans, Green & Co., under the title *Longmans' School Mensuration* (80 cents). It comprises reduction of denominate numbers and the calculation of lengths, areas, and volumes. There are a large number of examples at the end of each section, and several sets of examination papers have been introduced. A simple proof of nearly every rule is given. The diagrams illustrating the various figures and solids are very numerous, and have been carefully prepared.

The Step-by-Step Primer, prepared by Mrs. *E. B. Burnz* (Burnz & Co., 24 Clinton Place, New York, 25 cents), embodies a thoroughly scientific mode of teaching reading. The phonetic principle is the basis of its method, and the author does not allow any such host of exceptions and deviations from this principle as often makes what passes for "phonic teaching" into a mongrel practice. The author insists that the letters shall be regarded as standing for spoken sounds, just as definitely as the characters in a piece of music stand for musical sounds. No one can question that this was the intention of the ancient inventors of the alphabet, but the fact is too often lost sight of, especially by teachers of reading. In this primer each letter is made to show what sound it stands for, and the learner has only to combine these several sounds to get the whole word. This is effected by means of the Burnz's Pronouncing Print, the chief feature of which is that when a letter has an irregular sound this sound is indicated by a small subscript letter cast on the shoulder of the type. Webster's diacritics are also made use of, and silent letters are denoted by Leigh's hair-line type. Some Hints on Phonic Teaching are appended to the book. The primer is attractively illustrated and neatly printed.

In a volume of 443 pages, John C. Branner, Ph. D., State Geologist of Arkansas, has issued Vol. III of the *Geological Survey of Arkansas*. This volume concerns "whetstones and the novaculites of Arkansas," and was prepared by *L. S. Griswold*, assistant geologist. The whetstone industry is very exhaustively treated, and the admirable illustrations and maps will be found very useful. The last chapter is devoted to an interesting account of The Fossils of the Novaculite Area, and contains articles by R. R. Gurley, M. D., and Charles S. Prosser, on The Geological Age of the Graptolite Shales of Arkansas and Notes on Lower Carboniferous Plants. (Little Rock, Ark., Press Printing Company, 1892.)

Under the title *Coal Pits and Pitmen*, *R. Nelson Boyd*, M. Inst. C. E., has recast his publication *Coal Mines Inspection; its History and Results*. In this volume of 256 pages the author reviews the conditions of the mining operatives of Great Britain, and gives in somewhat of detail a history of the legislation for the prevention of the employment of women and children in coal mines. Considerable space is devoted to an examination of the causes of explosions in mines, and there are some excellent suggestions as to required legislation in the direction of increased inspection. In treating of the development of the coal industry in England the author gives some very interesting facts: for instance, toward the end of the eighteenth century the yearly output was estimated to be ten millions of tons—giving employment to fifty thousand work-people, whereas the

output of coal in 1891 reached the enormous total of one hundred and eighty-five millions of tons—giving employment to about six hundred thousand persons. The book contains some excellent illustrations, and will be read with interest by those who desire to study the social and labor questions. (London: Whittaker & Co. New York agents, Macmillan & Co. 1892.)

Few persons outside those connected with engineering business are aware of the importance of the pattern-maker. In a volume of 180 pages *A Foreman Pattern-maker* has embodied the most useful hints to apprentices and students in technical schools under the title *The Principles of Pattern-making*. The book is fully illustrated with one hundred and one engravings, and includes a useful glossary of the common terms employed both in pattern-making and molding. Considering the size of the volume it is really surprising to find such a fund of useful information upon the fundamental principles of pattern-making condensed into so small a space. The illustrations were nearly all made by the author himself, and are almost self-explanatory. It is published by Whittaker & Co., London. (New York agents, Macmillan & Co. Price, 90 cents.)

The Microscopical Examination of Potable Water is a little volume of 160 pages which contains a good deal of useful information concerning the best methods and apparatus necessary for the microscopical and bacteriological examination of water. The author, *George W. Rafter*, devotes considerable space to an explanation of the advantages of filtration by sand over the Parkins cloth method, and gives minute details of several examinations and analyses of the various public water supplies of the country, basing the arguments which follow upon the results of an examination of the Boston Sudbury River Water Supply. The remarks upon the effect of light upon the formation of starch in the algæ are interesting, and he claims that in certain lights the starch remains protoplasmic, and that a low temperature and darkness are unfavorable to the growth of algæ in the water supplies. The book is No. 103 of the Van Nostrand Science Series.

In a volume of 322 pages entitled *Figure Skating, Simple and Combined*, Messrs. *Montagu S. Monier-Williams*, *Winter R. Pidgeon*, and *Arthur Dryden*, the most eminent of British figure skaters, have given an elaborate treatise upon the development of figure skating in England. It is profusely illustrated with cuts and diagrams, and is published by Macmillan & Co., New York ($2.25).

Leonard Dobbin, Ph. D., and *James Walker*, Ph. D., D. Sc., have issued a useful handbook of 240 pages entitled *Chemical Theory for Beginners*. It is written with the object of assisting beginners in obtaining an elementary knowledge of the principles upon which modern chemistry is based. The chapters on Elements and Compounds, Chemical Action, Vapor Density, and The Kinetic Molecular Theory are interesting from a standpoint far advanced from the beginner. The use of symbols has been disregarded in this work, so that a very young student in chemistry will have no difficulty in understanding the most intricate examples of chemical compounds, etc., which are given. The kinetic theory of gases, as discovered by Clerk Maxwell and Clausius, is very simply demonstrated. The book is published by Macmillan & Co., of London and New York (70 cents).

In a volume of 978 pages the Interstate Commerce Commission has issued its *Third Annual Report on the Statistics of Railways in the United States*. It is a comprehensive tabulation of the classification, mileage, earnings, expenditures, and capital of the various railway systems of the country. In the reading matter which prefaces the voluminous and interesting statistics there is a complaint that the statistical data procurable from the monthly reports of the different railway corporations is of little value to publicists and economists; and it is claimed that the present system of bookkeeping in vogue among the accountants of the different roads "leads inevitably to an erroneous balance-sheet." The remarks upon and the statistics of the enormous increase of mileage will be read with interest by economists, and the fact that this increase is proportionately far greater in the Southern States will be a surprise to those who have not carefully observed the industrial progress of that section of the country.

D. C. Heath & Co., Boston, have issued a new publication entitled *The Complete*

Musical Reader, which is designed for "high and normal schools, academies, and seminaries." It is compiled and edited by *Charles E. Whiting*, and is really a most useful addition to the repertoire of school music books. The first forty-eight pages are devoted to musical notation, embracing exercises and solfeggios of a very educational type. The collection of two, three, and four part songs is excellent; but in the two latter sections some of the selections are rather difficult for beginners. Among the three-part songs is a novel arrangement of a solo with voice (duet) accompaniment—a style of voice culture that will probably become more general. The hymn tunes are easy, and will be found useful by teachers in connection with the rudimentary exercises and solfeggios. It contains 224 pages, and is published at 85 cents.

Recognizing the great agricultural depression existing in England and the apparent impossibility of farmers being able to prosper from the cultivation of grain crops, *J. Cheal*, F. R. H. S., suggests that cultivators of the land should consider what other means might be adopted in the way of yielding crops that would give more satisfactory returns. In his book entitled *Practical Fruit Culture*, which is published by George Bell and Sons, London, 1892, he advocates that, taking into consideration the "enormous quantities of fruit" imported into England for consumption there, fruit culture would be one of the best if not the most important means toward a renewed agricultural prosperity. The volume contains some excellent information upon the fruits most adaptable to the climate of Great Britain, and instructive hints as to their planting, cultivation, etc. (194 pages; price, 75 cents).

In a volume of 241 pages, C. W. Bardeen, of Syracuse, N. Y., has published three series of songs "for schools," which contain over three hundred selections. The first series is entitled *The Song Budget*, and is devoted to nursery rhymes and songs for young children; the second is called *The Song Century*, embracing some of the most popular standard songs; and the third, *The Song Patriot*, gives examples of patriotic songs, war songs, and national hymns. It is a useful cheap edition of song music, but the compiler has made some rather unfortunate omissions in neglecting to give the composers' names, while in at least one important instance wrong authorship is claimed. This, however, does not affect the arrangement of the music, which is excellent (price, 50 cents).

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Bidgood, John. A Course of Practical Biology. New York: Longmans, Green & Co. Pp. 353. $1.50.

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Sherwood, Sidney. The History and Theory of Money. Philadelphia: J. B. Lippincott Co. Pp. 413. $2.

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Yale Review, February, 1893. Quarterly. Boston: Ginn & Co. Pp. 454. 75 cents; $3 a year.

Zola, Émile. Modern Marriage. New York: Benjamin H. Tucker. Pp. 64. 15 cents.

POPULAR MISCELLANY.

Number of Glacial Periods.—An article by Prof. George F. Wright, in the American Journal of Science, is devoted chiefly to showing that certain points of evidence relied upon by those who believe that the "Glacial epoch" consisted of two periods of glaciation of similar extent separated by a long interglacial epoch, are insufficient to afford a basis for such a conclusion. Furthermore, the author adds to this: "As bearing against the duality of the Glacial period, it may be urged with great force that it is improbable that two periods should so nearly duplicate one another as these two are supposed to have done. To those who maintain the sufficiency of Croll's astronomical cause, however, this is rather an argument in favor. But, on the other hand, that cause would also demand a long succession of periods during all the geological ages, and of these we lack sufficient proof; while it would throw the two periods which Prof. Chamberlin recognizes back much farther than the facts will admit. It must be said, however, that it is not wholly out of analogy with known earth movements to suppose that

there has been in connection with the Glacial period a succession of oscillations of the earth's crust nearly duplicating one another. Such oscillations seem to have occurred in various geological ages, as, for instance, during the coal period, when the successive coal beds were formed. And, indeed, much can be said in favor of the view that such an oscillation when once begun would perpetuate itself. . . . But our knowledge of these matters is too vague to reason of it with any confidence, as is that also of the other causes which have been suggested for the production of the phenomena of the period. In conclusion, it is sufficient to remark that our present state of knowledge on the subject seems so imperfect that it is not conducive to success in investigation to hold any theory as to the unity or duality of the period with great positiveness. Overconfidence on this point at the present time is likely to blind the eyes of the investigator, and to hinder progress both in the collection and in the interpretation of the multitudinous and complicated facts which everywhere invite our close attention."

Preservation of Leaves as Fossils.—In a paper on the Preservation of Plants as Fossils, Mr. Joseph F. James, of Cincinnati, names as one of the requisites to secure the preservation of any plant, that it must be in a position to be almost immediately covered by some material. A leaf or branch falling to the ground and likely to be exposed to the elements has a poor prospect of being preserved. But if it fall into the water and, sinking to the bottom of a lake or swamp or morass, be covered by mud or sand; or if it lie on the seashore and be covered by sand brought in with the tide, it may at least leave its mark. Or it may, through certain chemical properties it possesses, so act upon the stone on which it lies as to be preserved, not in actual substance, but as an intaglio. The author was impressed with the possibilities of the last process while walking along the street in the rain and looking at the fallen leaves on the pavements. He first noticed numerous irregular, discolored patches on the stone slabs. Looking more closely, he says: "I found that these discolorations had been caused by the leaves, which had left their impress on the stone. In many cases this impression was so distinct that there was no difficulty in recognizing the species. The leaves were those of the soft maple, one or two species of oak, tulip tree, and sycamore. There is here a possibility of the preservation of the remains of plants, or, at all events, of their impress upon stone, had it occurred under more favorable circumstances. But on a pavement, where people were passing constantly, the impressions were worn off and soon disappeared. The rain, however, did not seem to wash them away, so they were something more than mere surface markings." A similar phenomenon was observed and described in 1858 by Mr. Charles Peach in a paper on the Nature Printing of Sea-weeds, on the rocks of one of the Orkney Islands in Scotland.

Breath Figures.—Some interesting experiments are described by W. B. Croft in the production of "breath figures"—or latent impressions on contact of objects with glass and electrifying, which are made visible by breathing upon them. While there appears to be no limit to the durability of these figures if they are carefully protected, they usually become obscured by dust gathering on them after being often breathed upon. But certain changes or developments take place after the lapse of some weeks or months. In coin pictures, the object is near to the glass, but not in contact with it; for in the best specimens the rim of the coin keeps the inner part clear of the surface. Even if a coin only rest for a while on glass, an outline of the disk and sometimes faint traces of the inner detail will be produced when the spot is breathed upon. An examination paper, printed on one side, put between two plates of glass and left for ten hours, either in the dark or the daylight, will leave a perfect breath impression of the print, both on the glass that lay against the print, and on that which faced the blank side of the paper. Sometimes both impressions are white, and sometimes they are both black; or one may be part white and part black, or may even change while being examined. The impressions were very easy to produce during a sharp frost with east winds early in March, 1890. The following experiments easily succeed at any time: Stars and crosses of paper are placed for a few hours beneath a plate of

glass; clear white breath figures of the device will appear. A piece of paper is folded several times each way to form small squares, then spread out and placed under glass; the raised lines of the folds produce white breath traces, and in one instance a letter-weight that was above left a latent mark of its circular rim. Some writing made on paper with ordinary ink and well dried, left a very lasting white breath image after a few hours' contact. Plates of glass lying for a few hours on a table cover worked with silk acquired strong white figures from the silk. Two cases have been reported where blinds with embossed letters left a latent image on the window near which they lay; it was revealed in misty weather, and had not been removed by washing. A glass which has lain above a picture for several years, but has been kept from contact by the mount, will often show on its inner side an outline of the picture, always visible without breath. The words white and black in the descriptions of the impressions relate to the adherence of the breath to the reliefs (white) or its non-adherence (black). The exact cause of the phenomenon is not known, but is supposed to lie in some of the unknown regions of molecular agency.

Exclusive Communities.—The number of ants dwelling together in a community, according to Sir John Lubbock, is sometimes as great as five hundred thousand. They are always friendly toward each other, no quarrel ever having been observed between two ants, members of the same community. They are, however, very exclusive, and regard an immigrant with horror. When an ant of the same species belonging to another nest appears among them, he is promptly taken by the leg or antenna and put out. It would naturally be surmised that this distinction was made by means of some communication. To test whether they could recognize each other without signs, attempts were made to render them insensible, first by chloroform and afterward by whisky. "None of the ants would voluntarily degrade themselves by getting drunk." Finally, fifty ants were taken, twenty-five from one community and twenty-five from another, and dipped into whisky until intoxicated. They were then appropriately marked with a spot of paint and placed on a table where the ants from one nest were feeding. The sober ones noticed the drunkards and seemed much perplexed. At length they took the interlopers to the edge of the moat surrounding the table and dropped each one into the water. Their comrades, however, they carried home and placed in the nest, where they slept off the effects of the liquor.

The Comma Bacillus, Cholera, and Sanitation.—Experiments by Prof. von Pettenkofer and Prof. Emmerich, in which they swallowed fresh cultures of comma bacillus upon empty, neutralized stomachs, show conclusively to von Pettenkofer that the comma bacillus, during its sojourn in the intestine, does not produce the specific poison that causes Asiatic cholera. This agrees with the results obtained by Bouchard, who was able to induce the symptoms of cholera in rabbits by giving them the excreta of human cholera patients, but not by giving them pure cultures of comma bacilli or their metabolic products. While he does not deny that the comma bacillus has some etiological importance, von Pettenkofer can not believe it is the x which, without the assistance of y, can cause epidemics of cholera; and he reiterates his well-known views on the influence of the soil, especially in connection with the rainfall. His practical teaching may be summarized in the formula that it is the y—that is, the local physical and sanitary conditions—that must be attended to; each place must, in short, be made cholera-proof by sanitation.

Children and Flowers.—In a paper read before the Society of American Florists, on training children to love and cultivate flowers, Mr. Robert Farquhar argued that we could either stifle or strengthen the love of Nature which is planted in every young heart. If we encourage and cultivate this love the mind of the growing child will be opened to the beauties of Nature, and we shall in this way provide for it a means of healthy exercise out of doors and a source of delightful recreation all through life. Children should have gardens of their own to care for, and they should be instructed in garden practice. They should be allowed to sow the seed and care for the plants themselves, although they should be directed in all these operations.

Florists who do business in villages and towns enjoy opportunities for doing effective work among children by explaining to their young visitors the methods of propagation. The claims of children should never be forgotten in making up the lists of premiums for agricultural and horticultural fairs. Prizes should be given for plants grown by them and for bouquets and collections of wild flowers made by them. Village improvement societies are doing excellent work in many sections. Some have distributed seeds and plants to the school children with most satisfactory results.

African Pluck.—Mr. Alfred Coode Hore, in his Eleven Years in Central Africa, speaks well of the tribes of the Tanganyika region, which he finds are peaceable and industrious for the most part, but turbulent and aggressive when they have learned to dread molestation by strangers. "It seems hard," he says, "that a man should be called lazy because he has ample leisure between his busy times; who has made with his own hands from Nature's raw materials his house, his axe, hoe, and spear, his clothing and ornaments, his furniture and corn-mill, and all that he has, and who, though liable often in a lifetime to have to commence that whole process over again, has the energy and enterprise to do so. Too often have the same people been called savage and bloodthirsty who, through all experience and by all their traditions regarding armed strangers as enemies, defend themselves and their own with the desperate energy which, as displayed by our own ancestral relations, we term patriotism and courage."

Impurities in Ice.—The once popular theory that water is purified by freezing is, as Mr. Charles Platt shows in Science, not in accordance with facts. While water in its crystalline state should theoretically be nearly pure, still, owing to its formation in needle-like crystals, considerable foreign matter present in the water in suspension may be and is mechanically held within the mass. Another view, that in the freezing of still water a certain concentration of some species of bacteria on the surface of the water may take place, and the first inch of ice may contain these in increased numbers as compared with a sample of water from the same lake, may be well founded, but it is not yet proved that these bacteria have an increased or any vital activity. But when the ice is melted and the temperature of the water is considerably raised, "then we have another problem, that of possible decomposition and organic change in those organisms that may induce results equal to and exceeding those of the bacteria themselves." Disease has undoubtedly, Mr. Platt affirms, been produced by the use of ice from impure sources, and this, too, when mere analysis of the ice in comparison with water standards would not condemn it. But the standards in the analysis of ice must be higher than in that of water. The Massachusetts Board of Health has pointed out that it is not the number of bacteria alone that is to be considered, but their kind, and insists that no water supply that is not fit for drinking purposes should be used as a supply for ice. This is done when ice is gathered from stagnant ponds and sluggish canals that receive the drainage from various sources. Snow ice and ice that has been formed by flooding ice fields with surface water are very liable to be contaminated. In making artificial ice it is customary to use the entire contents of the water tanks. In that case the impurities, repelled at first by the ice forming at the sides of the vessels, are driven to the center and there concentrated, to be at last included in the freezing of the entire mass.

Protection of Orchards against Frost.—According to Charles Howard Shinn, in Garden and Forest, experiments are carried on on a practical scale for the protection of fruit against frost in the orange groves at Riverside, Cal. In some winters the temperature falls so low that the oranges are destroyed or injured. As a remedy the cultivators are using appliances for warming the orchards on a large scale. Their experiments show that the temperature can be raised from four to ten degrees by the use of fires. The moment the thermometer falls to the danger point electric bells can be rung and tanks of crude petroleum lighted. One man has fitted up an eighty-acre orchard at a cost of $10,000 or $12,000. He claims that his grove is absolutely protected, and that the running expense will be very little. Other

growers use coal-oil cans filled with kindling wood and coal and placed in the orchard at the rate of from eight to twenty-five per acre. Some provide themselves with two-gallon iron kettles and use reduced petroleum. Ten dollars per acre will pay for the plant and the expense of one night's burning. Horticulturists in other citrus colonies are following in the track of Riverside and preparing for future "cold snaps."

Curious Fauna of La Plata.—A curious medley of animal life is described by Mr. W. H. Hudson as existing in the pampas region of La Plata: A poisonous toad which kills horses; the wrestler frog, which suddenly pinches its enemy with its fore legs and then runs away; a large, venomous, man-chasing spider, which pursues men on foot and on horseback; dragon flies, a single individual of which will cause clouds of gnats, mosquitoes, and sand flies to disappear in an instant; and an opossum, fully adapted to life in trees, which yet lives in a desert destitute of trees, and when brought to a tree, which it may never have seen before, will clasp it and climb it with all the agility of its forest-dwelling relatives of North America.

Manufacture of Fans.—The manufacture of fans is chiefly carried on now in France, Spain, China, Japan, and India. The fashions are established in France principally at Sainte-Geneviève, Audeville, Corbeil-Cerf, Le Déluge, Coudray, and the vicinity of Beauvais and Méru. At Sainte-Geneviève they work in bone, mother-of-pearl, and ivory; at Le Petit-Fercourt, and Andecourt, in mother-of-pearl and horn; at Le Déluge and Corbeil-Cerf, pear tree, apple tree, and hornbeam wood; at Boirsière, in bone; and at Paris, in shell. The leaf of the fan is generally made and the fan mounted at Paris. Fans have been made in Spain only for some sixty or seventy years, notably at Madrid, Barcelona, Valencia, Malaga, and Cadiz. Most of the Chinese fans are made in Canton and E-moui, but the manufacture is generally diffused through the country, for the fan is a part of the national costume. Every Chinese of good social standing holds a fan during visits of ceremony, and the custom of writing on fans is spread throughout the empire. The principal centers of production in Japan are the cities of Osaka, Kioto, and Nagoya. In that country the fan is a part of the costume of both sexes, and is to be seen in the hand of the soldier as well as in that of the monk. When a gentleman gives alms to a beggar, he often puts the coin upon his fan; and salutes are made by waving the fan as they are in Europe by tipping the hat. There are also fan factories in some other countries. Lace fans are made at Brussels and De Grammont, in Belgium; fans of braided straw, at Fiesole and Vicenza in Italy; and fan-standards of braided grass and cloth embroidered with gold and silver, in Tunis and Morocco; but France holds the first place in the manufacture of luxurious, and China in that of cheap, fans.

Origin of "Hot Waves."—A theory is published by Prof. F. Hawn, of Leavenworth, Kan., that our southwest winds are tropical currents, which rise to great elevations in the upper atmosphere, and then flow north and reach the ground again in latitude 34°, bringing subtropical heat. As other results of his theory he concludes that the close atmospheric relations between the upper and lower currents attest their common origin; that the atmospheric temperature is incidentally if not perpetually higher in the upper than on the lower levels; that these relatively higher thermal conditions of the upper atmosphere control the lower atmosphere in the spring and summer, and indidentally in the winter; that the hot waves of the Northwest have their origin in a superheated upper atmosphere, and are condensed by gravitation in their descent to the surface, evolving heat in a ratio inverse to the humidity; and that the *foehn* winds (hot waves), with their resultant temperatures of more than 100° in the temperate seasons and from 65° to 73° in the winter, are not local west of the eighty-eighth meridian, but at intervals simultaneously cover the northern half of the United States.

Qualities of Slates.—From experimental studies with roofing slates, Mr. Mansfield Merriman has drawn the conclusions that those with soft ribbons are of an inferior quality and should not be used in good work; the stronger the slate the greater are its tough-

ness and softness and the less its porosity and corrodibility; softness or liability to abrasion does not indicate inferiority, but is an indication of strength and good weathering qualities. The strongest slate stands highest in weathering qualities, so that a flexural test affords an excellent index of all its properties, particularly if the ultimate deflection and the manner of rupture be noted. The strongest and best slate has the highest percentage of silicates of iron and aluminum, but is not necessarily the lowest in carbonates of lime and magnesia. Chemical analyses give only imperfect conclusions regarding the weathering qualities of slate, and they do not satisfactorily explain the physical properties. The soft roofing slates weigh about one hundred and seventy-three pounds per cubic foot, and the best qualities have a modulus of rupture of from seven thousand to ten thousand pounds per square inch. The test of a slate by balancing it, striking it, and observing its ring is a good one, but is not susceptible of quantitative expression.

Pasteur's Seventieth Birthday.—The seventieth birthday of Louis Pasteur was imposingly celebrated December 27th, in the presence of eminent men of science and statesmen of different countries. The first address was made by the French Minister of Public Instruction, who spoke of the occasion as the "festival of France and of mankind." Addressing M. Pasteur, he said that while his work could be analyzed only by the scientific, the ignorant and the learned alike knew that he had accomplished something great. All his success was due to his unswerving "apostle's faith" in science. Had he devoted himself to pure science, the topmost place would have been his. Happily for himself and for mankind, he deserted that path and henceforth passed his days in inventing antidotes for diseases that had for centuries decimated the animal and human populations. Prof. Joseph Lister acknowledged the obligations of the professors of the healing art to M. Pasteur. Numerous testimonials and offerings of different kinds were presented to M. Pasteur, with a splendid gold medal, the product of an international subscription.

Origin of the Asteroids.—A paper on Groups of Asteroids, by Prof. Daniel Kirkwood, illustrates the theory that these bodies were formed by the resolution of nebulous asteroids. When the number of telescopic planets had grown to hundreds, and when the perihelion distance of some of them had become greater by many millions of miles than the aphelion of others, the theory of explosion was necessarily abandoned. But the doctrine of similarity of origin, the author holds, was not so easily disposed of. The original dimensions of nebulous asteroids were probably many times greater than those of the present bodies. The disrupting tendency of the great bodies of the system, especially when resisted only by the slight central attraction of nebulous asteroids, is easily imagined. Such separation, in short, has no improbability whatever. The dismemberment of comets, as is well known, has actually occurred under our own eyes. Why not also the pulling asunder of nebulous planets? The fact that in many cases the motions of asteroids indicate a common origin, affords strong presumptive evidence in favor of the nebular hypothesis. Possibly, indeed, its true form may have differed from that proposed by Laplace. How many primitive, separate nebulæ were contained in our system, and how many of these primitive masses suffered dismemberment while Mars and the then future earth were yet floating in the solar atmosphere, can not now be told. An indefinite number may, however, undoubtedly be traced. "May not similar processes be also indicated in the slow evolution of binary and multiple stars in the sidereal heavens?"

Early Fans.—The extreme antiquity of fans is attested by their appearance in ancient Egyptian and Assyrian sculptures, where they have the shape of a semicircle with a long handle attached at the center. They were probably used in worship to protect the offerings and sacred objects against contamination by dust and flies. They were known also in India, where they were perhaps introduced from China. The story of their origin in the latter country runs that the daughter of a powerful mandarin was obliged, on account of the heat, to take off her mask during the feast of lanterns, in violation of the law and convention. She shook it rapidly in front of her face, both to give herself air and by the quick motion to veil her identity as fully as

possible. Other women followed her example, and the fan was invented. The Chinese historians trace the use of the fan in their country back to a contemporary of Rameses II of Egypt; and it is mentioned by a writer of a thousand years before the Christian era. In ancient Grecian life, a eunuch, in one of the tragedies of Euripides, relates how he waved a fan, "according to the Phrygian fashion," before the hair, face, and bosom of the fair Helen. Fans were early adopted by Roman matrons, who had two kinds—the *flabella* of ostrich plumes, and the *labella* of thin woven stuff stretched over a frame. A Roman woman never went out without a slave (*flabellifera*) whose duty it was to fan her. It is not known whether the fan was used in Europe as an article of the feminine toilet between the fall of the Roman Empire and the eleventh century, for it is not mentioned in that relation; but it was certainly used a great deal in the ceremonies of Roman Catholic worship, when the deacons and the acolytes waved it over the altar at mass. This usage Père Bonami assumes to have traced back to the apostles. Fans are represented in manuscripts and on monuments of the twelfth century and inventories of the fourteenth, under different names, but without specification of their use. They seem to have been disused in the church in the thirteenth century, to appear again after the Crusades in the warmer countries—Spain and Italy—as an accessory to woman's dress; but were not seen in France till the sixteenth century, when they were introduced at court by the Italian perfumers who came in the suite of Catherine de Medicis.

American and African Deserts.—The most striking contrast between the North American "deserts" and those of North Africa is described by Prof. Johannes Walther, of Berlin, as consisting in the far greater wealth of vegetation which characterizes the former. In every direction the eye is met by the yellow-blossoming halophytæ, silver-gray artemisiæ, and prickly cacti; between the opuntias are found cushions of moss, and at the foot of the hills juniper trees seven feet high with trunks a foot thick. Such are the features of the landscape of the deserts of Utah, where plant-growth has completely disappeared only in those places in which the saline complexion of the soil kills vegetation. The Van Horn deserts in western Texas, and the Gila deserts in California are equally rich in vegetation; the altitude of these deserts above the sea-level makes no important difference. Either the mean rainfall in the American deserts is greater than in those of Africa, or else the flora of the American deserts is better adapted to a dry atmosphere. Although the deserts of the two continents present fundamental differences as regards vegetation, there is a surprising similarity between them as regards certain important and characteristic desert phenomena, especially with respect to the topography of the country. There is the prevalence of plains, with mountains rising from them like islands, with no intervening heaps of *débris* passing from the plains to the steep mountain slopes. This phenomenon is the more striking, as there are no rubbish deltas, even at the outlet of valleys a thousand feet deep. Another feature common to both is the large number of isolated "island" mountains and of amphitheatre formations in the valleys; also the intensive effect of insolation, which splits the rocks and flints, and disintegrates the granite into rubbish. The denuding influence of the wind is visible not only in the characteristics of the surface forms just mentioned, which differ in important points from erosion forms, but it can be directly observed in the mighty dust-storms which rush through the desert. In view of such agreement of important and incidental geological phenomena in regions so remote from each other, the phenomenon of desert formation must be considered to be a telluric process which runs its course according to law, just as the glacial phenomena of the polar zone or cumulative disintegration in the tropics.

Wind Effects.—In a paper on The Wind as a Factor in Geology, published in the Engineer's Magazine, Mr. George P. Merrill, after mentioning several familiar examples of the formation of dunes in Europe, passes to the account of similar phenomena in the United States. In May, 1889, a dust-storm occurred in Dakota during which the soil was torn up to a depth of four or five inches and scattered in all directions; while drifts

of sand were formed, several feet deep in favorable places, packed as snow-drifts are packed by a blizzard. In parts of the Western plains the fine, loose sand has been blown away at times, leaving every pebble and large bowlder standing out in bold relief. The loose material often gathers in the form of drifts or dunes, which travel across the country with frequent changes of outline. A few miles north of Winnemucca Lake, in western Nevada, is a belt of these drifting sand hills, described by the geologist Russell as some seventy-five feet in thickness and about forty miles in length by eight miles in breadth. Another range of sand dunes, at least twenty miles long, and forming hills some two or three hundred feet high, is on the eastern end of Alkali Lake in the same State. Dunes of equal height have been formed on the eastern shore of Lake Michigan, and at Grand Haven and Sleeping Bear have drifted over the woodlands, so as to leave only the dead tops of trees exposed. The erosive power of these drifting sands is often an important agent in wearing away the rocks upon which they strike. Carried along by the force of the winds, they work effectively in undermining cliffs, scouring down mountain passes, and giving curious and fantastic forms to prominent rocks.

The Whistled Language of the Canary Islands.—As a result of his studies of the whistled language of Gomera, in the Canary Islands, M. J. Lajard affirms that it is not a special idiom or a whistle which tries to imitate the Spanish language; but it is the Spanish language strengthened by the aid of whistling. "The Gomerian, while he is speaking, puts one, two, or four fingers in his mouth, as we sometimes see done in the street in order to make shrill sounds, and at the same time he whistles with force. There results a mixture of words and whistle, unintelligible to ears not accustomed to it, but in which can be distinguished the words of the language. . . . The whistling, then, is only an artifice employed to carry to a distance the sound of the voice, to the detriment of its distinctness and tone-quality. This last inconvenience is so great that up to this time travelers have been unable to understand the whistled language. To be able to understand it, you must know how to whistle yourself." It is, however, very limited in its compass, and whistled conversations are of short duration. It exists in other of the Canary Islands than in Gomera, and there is reason for believing that it was formerly more widespread and more prevalent than now. Rudiments of a whistled language, the mechanism of which is like that of the Canaries, exist even in Paris; it is employed by butchers and by thieves.

What constitutes a Polluted Water.—A water is said to be polluted, according to Prof. von Pettenkofer, when it is no longer clear and inodorous, when fishes and plants perish in it, and when it contains more organic matter and less oxygen than are to be found in the unpolluted portions of the flow of the stream. Such contamination is essentially different from the transient turbidity due to heavy rains or to melting snow. Still, even the permanent pollutions disappear in the further course of the river bed, by deposition and other agencies. Here the rapidity of the stream and the quantity of the water exert a preponderating effect. The most formidable impurities are supposed to consist of the putrescent refuse which flows out of sewers of cities, and quickly produces an offensive odor at the places where it accumulates. Prof. von Pettenkofer has for many years given his attention to the question of the extent to which rivers are polluted by such agencies, and has had researches conducted by his pupils. But nothing has hitherto altered the opinion which he expressed long ago, that sewage may be safely permitted to flow into a river if its volume is not more than one fifteenth that of the river water, and its rate of flow is decidedly greater than that of the current. Taking the city of Munich, which has 280,000 inhabitants, he computes the pollution of the Isar by its sewage as amounting to only $\frac{1}{100000}$ of the discharge of the river—a pollution so inconsiderable that it can not be detected by the eye when a corresponding mixture is made up experimentally. But it is also not permanent, for at Ismaning, seven kilometres below Munich, the sewage influx is no longer to be detected; and at Freising, thirty-three kilometres below, the chemical and bacteriological

tests show that it has lost nearly all its power of pollution. Thus, the number of 198,000 bacteria per cubic centimetre found by Prausnitz at the mouth of the Munich sewer was reduced at Ismaning to 15,231, and at Freising to 3,602. A similar result was obtained by Frankel with the water of the Spree at and below Berlin. The mere number of bacteria found has, however, no sanitary significance, since these particular microbes are mostly harmless, and in fact destroy the pathogenic microbes in the struggle for existence. The purifying action of rivers is ascribed by von Pettenkofer to the oxygen dissolved in the water in a free state or separated from organisms. In the latter respect the green algæ and even non-chlorophyllic plants come prominently into consideration. This vegetation should be preserved; but it may be destroyed by a too great concentration of the water to be purified; and to prevent this, industrial waste waters which destroy vegetation must be kept out till they have been purified.

Bacteriological Processes against Disease.—According to a summary in the Saturday Review, attempts by bacteriological processes to remove from the human system the germs of infectious disease have been made by six different methods. The first is by Pasteur's preventive inoculation, in which a minute quantity of an attenuated culture of the virus is administered to produce a light attack of the disease. The second is M. Pasteur's method in rabies, in which a mitigated virus is injected into a person already attacked with the disease, to overtake it. The third is the employment of the virus of a comparatively mild disease to protect against a more severe one, as in vaccination for smallpox. Next in order is the destruction of the disease-producing bacteria by the administration of antiseptics or bactericides. A fifth method is the re-enforcement of natural means possessed by our systems for combating disease germs: by re-enforcing the leucocytes or white blood-corpuscles, which destroy bacteria, by means of the injection of the blood of animals insusceptible to the disease; by raising or lowering the temperature of the body of the patient; by alterations of diet, climate, or surroundings; or by injection of phagocyte invigorators. The sixth method is by the injection of the "toxalbumens" formed by the bacteria growing in artificial cultures, as is done in Koch's method for tuberculosis. That these methods have not proved entirely satisfactory, and bacteriological treatment is now apparently at a standstill, is not due, it is thought, to any innate defect in the system, but to some technical detail. "When the ingenuity of man has arrived at the point of being able to prove absolutely that organisms, completely invisible to all but the highest magnifying powers attainable, cause each its particular infectious disease; when these tiny things may be made to grow like plants in a garden, separately and in order; when we can keep rows of tubes each with its deadly contents on our laboratory shelves, or in our incubators, like druggists' bottles of inert powders or crystals—surely we shall not stop at this stage in our control over this 'world of the infinitely little.'"

NOTES.

A CLARIFICATION of muddy liquids and partial separation of micro-organisms is effected by M. R. Lezé by subjecting the liquid to a rapid rotation. Thus, cider, in turbid fermentation, after being whirled in a turbine wheel, came out clear; and while specimens kept in bottles at 86° soon generated bacteria, the yeast and alcoholic fermentation had all disappeared. This method may be found useful in bacteriological investigation; and in industrial operations, for ridding impure and unhealthy waters of most of the organisms contained in them.

CHEMICAL analysis has been applied by M. Berthelot to the solution of a problem in archæology. Taking a piece of copper found by M. de Sarzec in his explorations of the ruins in Mesopotamia, which was obtained from one of the most ancient sites, he made an exact determination of its composition. It contained no tin or zinc, and only slight traces of lead and arsenic. It had been oxidized throughout, and presented itself as a suboxide or a mixture of protoxide and metallic copper. Hence, while the question can not yet be considered decided, the specimen is a contribution of evidence in favor of the existence of an age of copper.

THE physicians of Massachusetts have in recent years noticed a development of malarial disease in Cambridge and the vicinity of Boston and in other towns of the State. The origin of the cases in Cambridge seems, from the investigations thus far made, to be

associated with the excavations of brickyards. The examination of cases in the suburbs of Boston points to the upper waters of certain streams.

A VERY simple remedy for the annexation fever now beginning to prevail in Canada and the exodus to this country which is in full flow, is proposed by Mr. Allen Pringle. It is to "take down the bars" between Canada and her natural market—to cultivate friendly and intimate commercial relations with the United States.

A PATENTED substance called alumino-ferric is prepared by English manufacturers, to promote the precipitation of sewage. It is used solid, in slabs twenty-one inches long by ten inches wide and four inches thick, which are placed in a cage fixed in the flow of the sewage, or in solution. The "sludge" is deposited, to be separately carried off or made into manure, and clear water flows away. The use of this substance has been very successful.

PROF. H. CARRINGTON BOLTON has been elected President of the New York Academy of Sciences.

THE Department of Ethnology and Archæology of the Columbian Exposition intends to provide as complete an anthropological library as possible, by aid of which students and educators may be enabled to become acquainted with the mass of literature on the subject. All authors, societies, museums, and publishers are invited to contribute from their stores all publications on the various branches of the subject. A complete catalogue of the collection will be published and widely distributed. The library will be conveniently and properly arranged and accessible to students, and full information will be given them respecting the books. At the close of the Exhibition loaned books will be returned, and the rest of the library will be placed in the permanent Memorial Museum of Science which is to be established in Chicago.

IT is said that the passage of boats containing naphtha has had the effect of poisoning the waters of the Volga. A great deal of the liquid is transported in badly built wooden barges, with a resultant loss by leakage of about three per cent. Consequently the fish are decreasing rapidly, and have already become extinct in some places where the boats stop. The naphtha likewise kills off the insect life on which the fish feed, by being carried in times of flood to the adjacent meadows and destroying the larvæ there.

THE New York branch of the American Folk Lore Society was organized at the house of Mrs. Henry Draper, February 24th, when a constitution was adopted, and officers were elected as follows: President, H. Carrington Bolton; vice-presidents, G. B. Grinnell, R. W. Gilder; treasurer, H. M. Lester; secretary, William B. Tuthill. These officers and Mrs. Harriet M. Converse, Mrs. Anna P. Draper, and Mrs. Mary J. Field, constitute the Executive Committee. Papers were read at the meeting by Prof. Bolton on Divination by the Mirror as practiced in New York To-day, and by George Bird Grinnell on How the Pawnees stole the Corn. Mr. G. F. Kunz exhibited a human tooth inlaid with jadeite. Mr. Newell, founder and secretary of the National Society, was present and made some remarks.

OBITUARY NOTES.

THE death was announced about the beginning of the year of General Axel Wilhelmovitch Gadolin, of the Russian army, an eminent mineralogist and physicist, and a member of the Russian Academy of Sciences. He engaged, when not active in military duties, in research into the molecular forces that act in the formation of crystals. His chief work, which is also known to the world through a German translation, was his Deduction of all the Systems of Crystals and their Derivates from a Unique Principle. A paper on the resistance of the walls of a gun to the pressure of gunpowder gases is also noticeable for having given a new formula of minimal resistance.

NIKOLAI IVANOVITCH KOKSHAROFF, who died in St. Petersburg January 2d, was an eminent mineralogist and author of a work in eleven large quarto volumes, to which a twelfth is to be added, of contributions to the mineralogy of Russia.

M. FRANÇOIS VAN RYSSELBERGHE, Professor of Electrotechnics in the University of Ghent, and a famous inventor, died suddenly at Antwerp, Belgium, February 3d, in the forty-seventh year of his age. Among his inventions were a universal meteorograph, exhibited at Paris in 1881, which registered periodically on a strip of paper the pressure, temperature, humidity, depth of rainfall, and direction and force of the wind; and a system of simultaneous telegraphic and telephonic transmission which has come into general use on urban and suburban lines. He was counsel in electrical matters for the Belgian administration of railroads, posts, and telegraphs.

MR. HENRY F. BLACKFORD, a distinguished geologist and meteorologist of India, died in January. Originally attached to the Geological Survey of India, in connection with which he wrote several memoirs of much value, he afterward became Superintendent of the Meteorological Department of Bengal, and ultimately of the whole of India; and in connection with this position also he published useful books and papers.